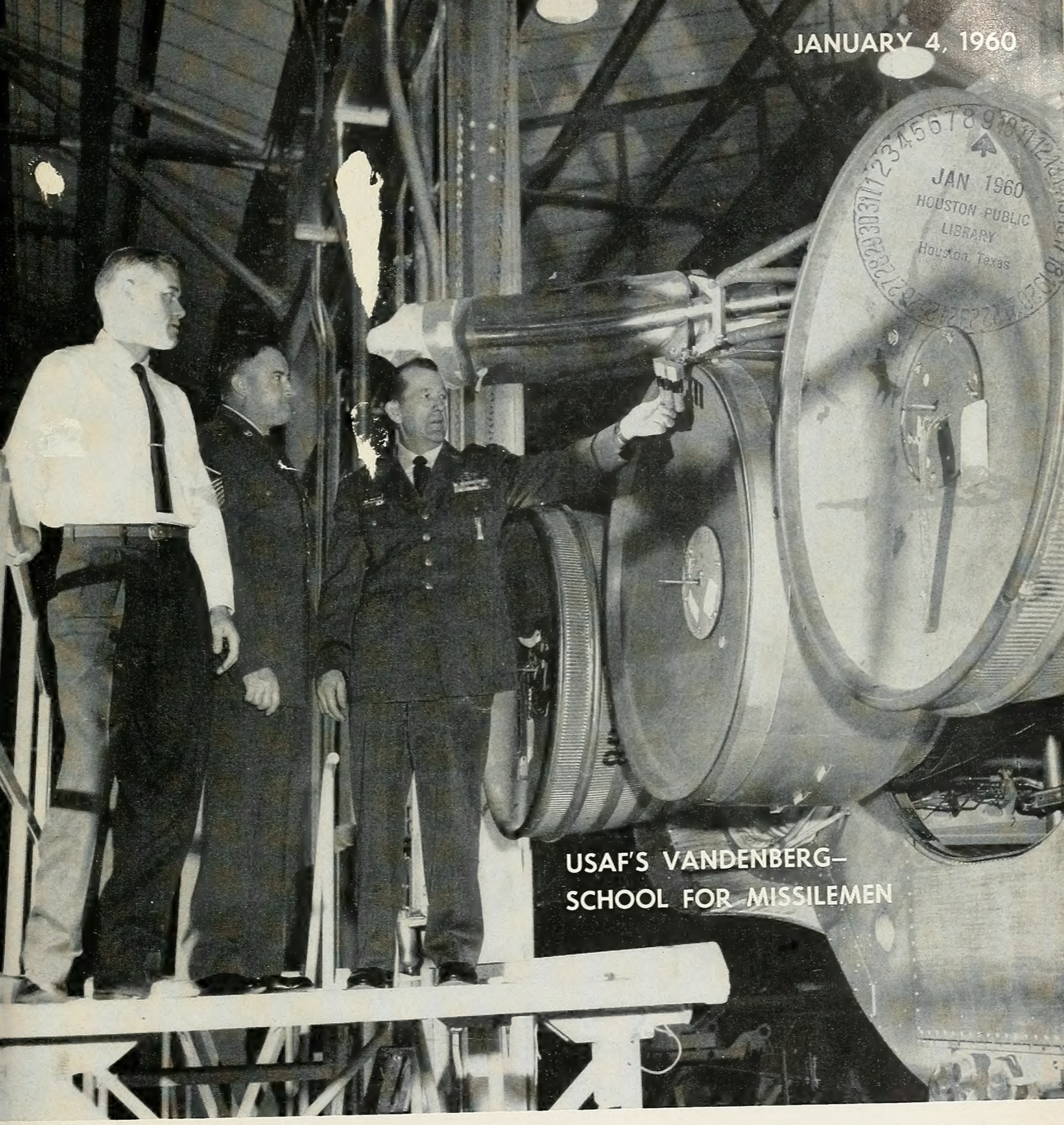
JANUARY 4, 1960



USAF'S VANDENBERG—
SCHOOL FOR MISSILEMEN

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Per

AN AMERICAN AVIATION PUBLICATION

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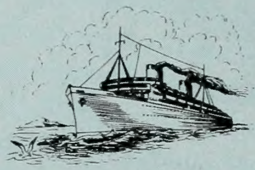

LEACH RELAY COMPANY

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(from original Leach catalog)

A HERITAGE IN ELECTRONICS

Val Leach, founder of Leach Corporation, wrote the above advertisement 27 years ago. In it Mr. Leach laid down a business philosophy that is as valid today as it was in 1933. He knew there would be no room for "yesterday's heroes" among the companies supplying the vital, growing electronics industry. He knew that success would be in direct ratio to uncompromising product reliability. And he also knew that technological progress could only be based on the solving of tomorrow's problems.

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. . . . . with the know-how to incorporate them into **ELECTRONIC SUB-SYSTEMS AND SYSTEMS.**

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LOOK TO LEACH

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Missiles and Rockets Volume 6 Number 1

Published each Monday with the exception of the last Monday in December by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Wayne W. Parrish, *President;* Leonard A. Eiserer, *Executive Vice President & General Manager;* Fred S. Hunter, *Vice President & Editorial Director;* A. H. Stackpole, Eric Bramley, Robert R. Parrish, *Vice Presidents.*

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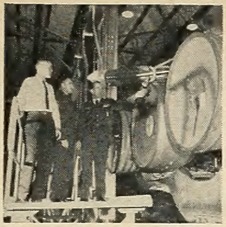
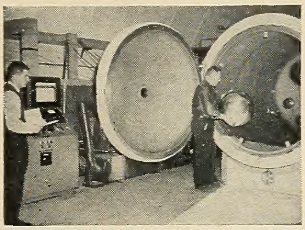
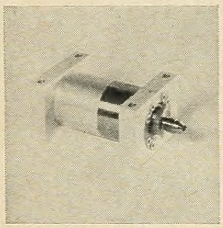


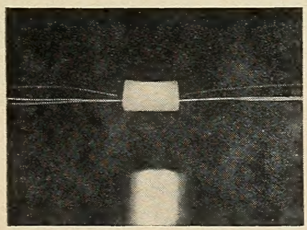
COVER: The Air Force is now stepping up its training program at Vandenberg AFB, Calif., for ICBM launching crewmen. A special report, with pictures, begins on p. 12.



NEAR-VACUUM conditions of 100-mile altitude are duplicated in this test chamber at Army's Signal Research and Development Laboratory. A report on growing vacuum technology starts on p. 16.



TRANSDUCER problems are being solved with introduction of units like this Model CP-40 pickup by PACE Engineering Co. For a survey of recent progress in this field, see p. 20.

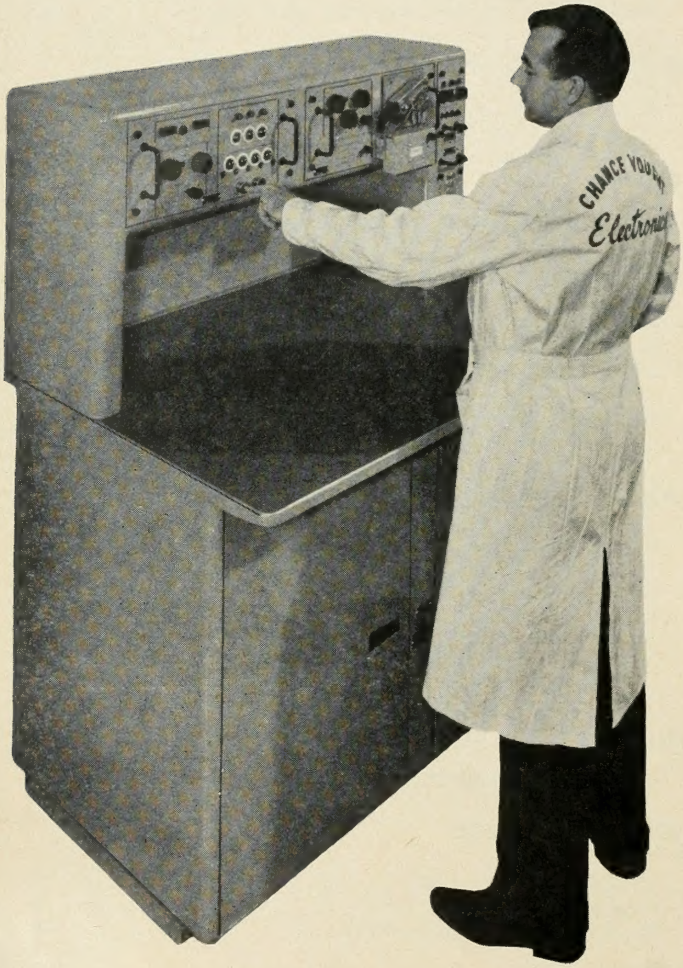


CYLINDER of Teflon 7 TFE resin retained general shape after 117 sec. in Bunsen burner flame. Its manufacturer, DuPont, has raised the insulation's effective operating temperatures as result of testing. See p. 23.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

30,700 copies of this issue printed


CHANCE VOUGHT
Electronics

Washington Countdown

IN THE PENTAGON

1960 R&D launchings . . .

scheduled by the military services include:
. . . The Air Force's *Discoverer IX* about mid-January.
. . . The second ARPA-Navy *Transit* navigational satellite in February.
. . . The first ARPA-Army *Courier* communications satellite about April-May.
. . . The first Air Force *Samos* reconnaissance satellite about June.
. . . The first two *Midas* early warning satellites by about June.

• • •

The Army's missile arsenal . . .

is expected to receive two new operational missiles this year. Number one: The surface-to-surface **Emerson** *Little John* which replaces the **Douglas** *Honest John*. Number two: The surface-to-surface **JPL Sperry** *Sergeant* which replaces the **Firestone** *Corporal*.

• • •

Some 40 more *Polaris* shots . . .

are scheduled this year before the Navy plans to put the first operational missiles on station in the nuclear-sub George Washington. So far 45 of the **Lockheed** *Polaris* test vehicles have been launched.

• • •

The coming threat . . .

of air-breathing air-to-surface missiles launched from Soviet bombers will be met, the Army believes, by the **Western Electric** *Nike-Hercules*. The *Hercules* has already been successfully tested against air-launched supersonic jet drones.

• • •

AT NASA

NASA will ask . . .

Congress for about $30 million in extra funds for FY 1960 almost as soon as the new congressional session gets underway. The supplemental request—about $8 million more than Congress cut from NASA's budget last year—is urgently needed for Project *Mercury*. Some also will go to development of **Pratt & Whitney's** liquid hydrogen *Centaur* engine.

• • •

The search for cash . . .

to support *Mercury* already has forced NASA, temporarily at least, to ax two programs and divert their funds. One is advanced studies on rendezvous capability—$3 million. The other is studies on orbiting laboratories—$2 million.

Meantime, the new NASA budget . . .

for FY 1961 still is being held at about $730-million—plus funds for *Saturn* and the tentatively acquired Army Ballistic Missile Agency. Critics complain that the proposed budget will not speed up current programs and will start few new ones.

• • •

Soaring costs, unrealistic estimates . . .

are plaguing the space agency. For example: *Mercury* now is expected to cost about $100 million more than estimated a year ago.

• • •

Saturn's first static test . . .

firing may come in March. That's the ABMA team's target date—about the time when Congress will be determining how much to spend on the program. However, the test of the big booster—originally scheduled for last December—could be delayed until summer if technical snags arise.

• • •

ON CAPITOL HILL

First blood . . .

in the sweeping congressional investigations into the nation's lagging space program is expected to be drawn by the House Space committee. It tentatively plans to begin four to six weeks of hearings at 10 A.M. on Jan. 18. First witness: Probably Secretary of State Herter. The question: How is running second to Russia in space hurting U.S. foreign policy? (See this issue, page 11.)

• • •

The long-awaited Hébert report . . .

on the House investigation of the so-called "munitions lobby" is now expected to be out about mid-January. Publications of the report and accompanying legislative recommendations has been held up by technical publication difficulties.

• • •

AROUND TOWN

Some of the "reports" . . .

heard around the nation's capital:
. . . The **Western Electric** *Nike-Zeus* AICBM is being fired against jet target drones in early test shots.
. . . The United States is cool to French requests for technical assistance in developing nuclear-tipped IRBM's.
. . . Russia is lining the Soviet-Red Chinese border with missile bases.

Industry Countdown

MANUFACTURING

None too cheery 1960 . . .

is forecast by AIA President Orval R. Cook for the missile/aircraft industry. He sees the increasing trend toward R&D contracts continuing to adversely affect earnings. Profits of the 12 major airframe companies, Cook notes, slid substantially in the first nine months of 1959; total for the 12 was $44.6 million compared to $105.8 million for the same period in 1958.

• • •

Cook blames the decrease . . .

in profits mainly on contract cancellations and stretchouts, economic limitations and "proportionately more R&D contracts than production contracts." According to AIA figures, the total backlog of the major companies has dropped $1.1 billion in less than a year—from $13.2 billion on Dec. 31, 1958, to $12.1 billion on last Sept. 30.

• • •

Last major buy . . .

of *Lacrosse* surface-to-surface missiles will be made in the last half of FY 1960 by the Army. They will be purchased from **The Martin Co.** to equip the last three of seven planned battalions (four missiles each). Future buys will be replacements only.

• • •

Crew training . . .

for launching the **Douglas** ALBM probably will be conducted by the Air Force at Vandenberg AFB, Calif., where ICBM crews are being schooled now.

• • •

Belgium's Army is replacing . . .

its 90 mm cannons with *Hawk* anti-aircraft missiles. And the country's Air Force has lopped off three pursuit squadrons with the installation of *Nike* batteries.

PROPULSION

Lighter and more powerful . . .

Atlas engine will be delivered soon to the Air Force by **Rocketdyne.** The new MA-3 system consists of two low-altitude boosters, a high-altitude sustainer and two small verniers. Weight was reduced by substituting fibreglas for metal banding around booster combustion chambers. Components have been cut by 15% through new controls which permit the fuel to operate engine sequencers.

• • •

Pad damage . . .

apparently was superficial in the explosion of an advanced *Polaris* motor on an **Aerojet-Sacramento** test stand Dec. 15 . . . *Polaris* is said to be having liner problems causing case burnout.

• • •

Minuteman nozzle erosion . . .

is being studied by Aerojet-General, using a liquid rocket which can be cut off at any point—an advantage not possible with a solid rocket.

ASTRIONICS

Changes in plans . . .

and soaring costs are expected to add several million dollars to NASA's world-wide *Mercury* tracking range, originally estimated at about $27 million. **Western Electric** is now negotiating the contract at Langley Research Center.

• • •

Mergers & Expansions . . .

Midwestern Instruments, Tulsa, Okla., has agreed to become a division of **Textron Electronics** . . . A new $500,000 plant is being built at Anaheim, Calif., by **Photocircuits Corp.** of Glen Cove, L.I. . . . **RCA** is consolidating its Washington operations under one roof—a newly-leased building—as of March 1 . . . and **Technology Instrument Corp.** of California has opened a new environmental test lab at Newbury Park, Calif.

WE HEAR THAT—

Aerojet-General is buying . . .

radio and television station **WRC,** Washington, D.C., from **NBC**—a real switch in the usual diversification pattern . . . Britain may sell its Short *Seacat* anti-aircraft missile to the German Navy . . . Team of **American Machine & Foundry** and **American Car & Foundry** is expected to be named winner of the competition for the mobile railroad launching system for the **Boeing** *Minuteman* ICBM . . . The **Hamilton Standard Division** of **United Aircraft Corp.** is purchasing a 50% interest in **Microtecnica Inc.,** Turin, Italy.

More About the Missile Week on Page 48

GAM-77 HOUND DOG air-to-surface missiles give SAC's B-52G intercontinental bombers the versatility of a champion boxer. Even while the aircraft carrying the GAM-77 missiles is airborne, a new target can be selected. Then reaching out at supersonic speeds after launch, the GAM-77's can flatten opposition for the bomber to deliver its own Sunday punch...or independently destroy the primary target. These jet-powered missiles vastly increase the striking power of the giant Boeing B-52...give it a triple-punch capability.

Guided by a self-contained inertial autonavigator—set before launch by the B-52's crew—the GAM-77 can't be jammed, can't be decoyed. The GAM-77 Hound Dog was designed and is being produced for the USAF by the Missile Division of North American Aviation.

MISSILE DIVISION

NORTH AMERICAN AVIATION, INC.

Downey, California

many-angled attack . . .

Congress Takes Up Missile/Space Lag

Some seven congressional committees expect to begin probing the nation's programs this month; pace will increase as election nears

WASHINGTON—Angry and worried congressmen this month will begin digging into the nation's lagging space and missile programs in one of the most exhaustive series of investigations in recent years.

At least seven committees in the House and Senate will attack from a score of directions the problems posed by Russian space supremacy and missile might.

The men and military officers charged with running the U.S. space and missile programs will pass before the committees in a parade that is expected to last for months.

The atmosphere of the hearings—already supercharged by the importance of the issues at stake—will become ever more electric as the 1960 presidential election campaign increases its pace.

• **Block from White House?**—The White House may attempt to cut the ground from beneath the investigations.

President Eisenhower is understood to have directed before leaving on his overseas tour that officials be prepared when he return to lay before him the entire East-West space situation. Some officials have interpreted this as a prelude to announcing a somewhat bigger and faster-moving space program in the President's State-of-the-Union address.

However, congressmen concerned about continuing Soviet space triumphs contend that words and half-way measures will not be enough either to overtake Russia or dull the edge of the congressional investigations.

• **The lineup**—The seven committees expected to take the lead in the investigations are: the Senate and House Space Committees, the Senate and House Armed Services Committees, the Senate and House Appropriations Committees and the House Military Operations Subcommittee.

The House Space Committee is expected to open its hearings first on Jan. 18—the day the President will send his annual budget message to Congress. The opening witness probably will be Secretary of State Christian Herter. He will be asked how being a second-class space power is hurting our foreign policy.

Others expected to be called in rapid order are Defense Secretary Thomas S. Gates, NASA Administrator T. Keith Glennan and the members of the Joint Chiefs of Staff. The hearings are expected to run four to six weeks. Then the committee will swing into extensive hearings on the NASA authorization bill for its FY 1961 budget.

The Senate is expected to begin its hearings by the end of the month, probably with the Senate Space committee taking the lead. However, Senate Democratic Leader Lyndon B. Johnson may decide to have the Senate Preparedness Subcommittee—which he also heads—conduct the initial investigation.

Meantime, the Armed Services and Appropriations Committees in both houses will begin digging into the space and missile programs under their own special jurisdictions.

The House Appropriations Committee hearings will be closed. However, the others will be mostly open. The House Military Operations Subcommittee is expected to postpone opening any hearings until it sees which areas might be more thoroughly explored.

In all of these hearings, congressmen will be asking variations on four overriding questions:

• Why are we behind Russia in space?

• Do we have a strong enough military machine?

• What more should we do?

• Who is to blame for the lag?

The questions have been asked many times in the past. Congress is going all out this time to get some straight answers.

Basic Questions

The nation's space and missile programs will undergo one of the greatest workings over by Congress in recent years.

The White House may attempt to cut some of the ground from beneath Congress by announcing some new programs this month, before the investigations even start. But the attempt isn't given much chance of success.

The basic questions that Congress will ask are:

Why are we behind Russia? What can be done about it?

And intermixed with it all is the heady atmosphere of a presidential election year—and the juicy question: Who is to blame?

All are old questions. Congress is seeking some new answers.

AF Training 14,000 ICBM Crewmen

Combat missilemen now fill pipeline; industry and Air Force develop radical techniques for schooling Atlas and Titan crews in factories and on the pad

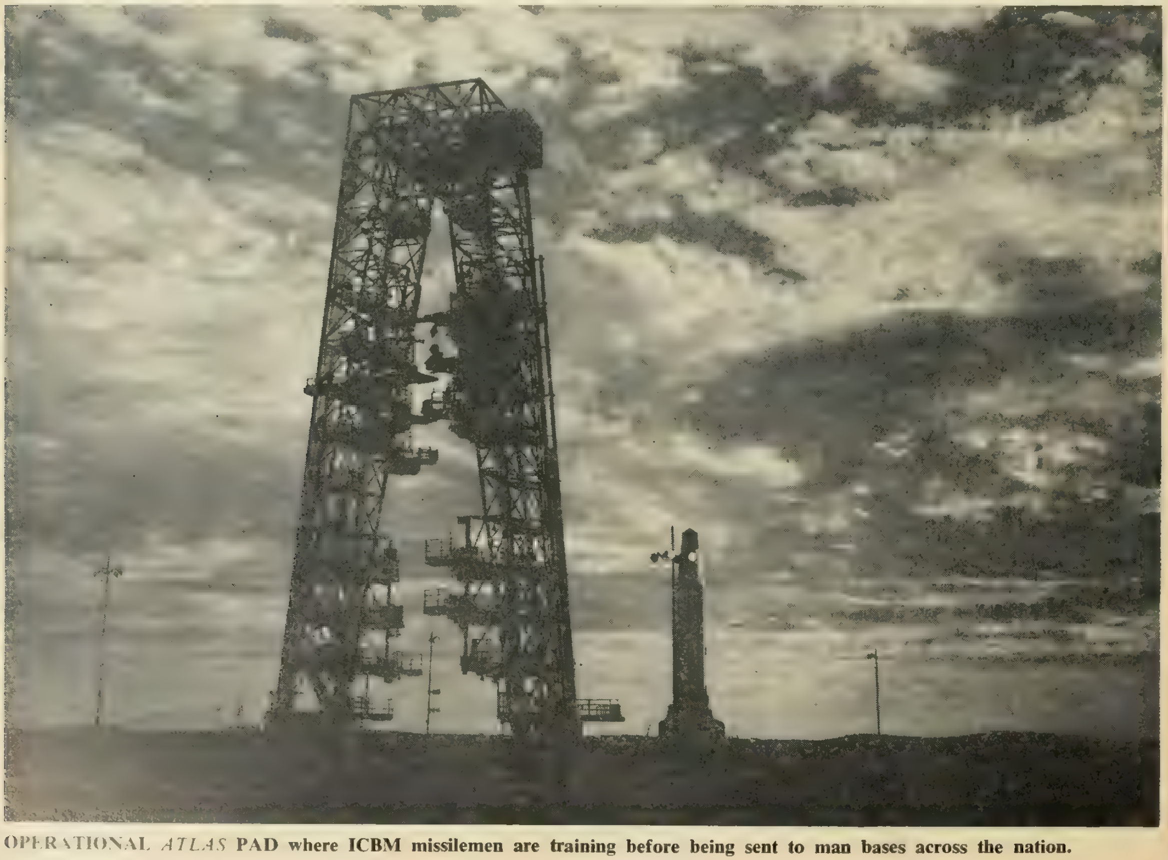
by James Baar and William E. Howard

VANDENBERG AFB, CALIF.—The Air Force today is moving swiftly into the wholesale—yet meticulous—training of 14,000 hand-picked officers and men in the exacting art of launching combat ICBM's.

These trainees will become an entirely new breed of earthbound "airmen" who will man the nation's first 180 *Atlas* and *Titan* missiles—20 squadrons—at wartime readiness around the clock. In the next few years, their ranks will be swelled by the future crews for hundreds of fixed and mobile-based *Minuteman* ICBM's.

On all of these missilemen will rest the final, enormous responsibility of ensuring that night and day the retaliatory missile-might of the Strategic Air Command is "in the green."

Time already is closing in. This year some 600 men must be fully trained and prepared to take over operational control of the 564th Strategic Missile Squadron at Warren AFB, Cheyenne, Wyo. This unit will man a complex of six *Atlases* now nearing completion. And it will be followed within a few months by a second opera-



OPERATIONAL *ATLAS* PAD where ICBM missilemen are training before being sent to man bases across the nation.

tional unit—the 565th SMS—at Warren.

The exact number of ICBM crewmen scheduled to pass through Vandenberg in this first year of full-scale training is classified. However, the base is ready now to handle several thousand men at one time.

Since the activation of Vandenberg a little over two years ago, the main effort in the ICBM training program has been directed at building up a cadre of Air Force men to become the permanent teaching force. Until the present, the program has had to rely heavily on industry contractor personnel to instruct the cadre at the three operational gantry-type pads of the 576th SMS, which is both a training and an operational squadron.

The Air Force hopes very soon to take over the pads with a complete "blue suit" capability and retain only a bare minimum of contractor instructors.

These operational ICBM's—the nation's first—will be supplanted later this year by a complex of three aboveground emplacements in which birds of the *Atlas D* series are stored horizontally and erected only for launching. This complex, similar to the six-missile complex being completed at Warren AFB, will be called the 576th "B" SMS.

ICBM training is broken down into three major phases:

• Up to three months at factory schools learning, as one launch control officer puts it: "From blueprint to component, system by system how the whole bird is put together."

• Up to three months "on the pad" at Vandenberg learning how to operate and maintain the weapon and to be able to launch one within 15 minutes.

• Periodic retraining.

Every launch crew is supposed to take part in some degree in a live firing before taking up its vigil at a combat emplacement in the American mid-continent. It is indicative of the status of the program that only one such training shot has been held so far. That was last September. The tempo should pick up shortly.

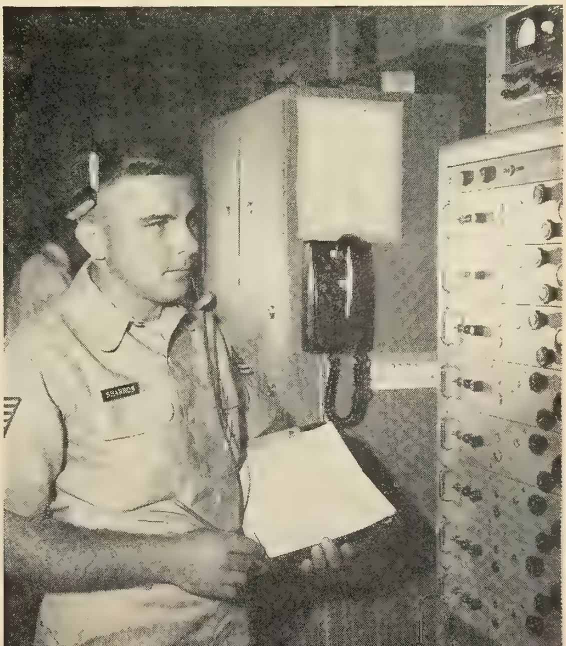
• **Three shifts**—The men to make up five *Atlas* launch crews arrived on the base Jan. 1. More are coming in daily. Within weeks, the Air Force expects to be training 10 crews at a time here on a three-shift basis.

Conducting the first phase schools for *Atlas* are the prime, **Convair Astronautics; General Electric** (re-entry vehicle and radio inertial guidance); **Burroughs Corp.** (ground computer); **American Bosch Arma** (all-inertial guidance); **Rocketdyne** (propulsion); and the Air Training Command.

The *Titan* lineup includes **The**

TRACK ANALYST at console supervises hundreds of precise adjustments as an *Atlas* roars towards its target. He is one of the first of *Atlas* trainees who are being formed into training cadres.

TECHNICAL ADVISER to the launch control officer works at his post at the launch analyst console. Men spend long days at launch pads, long nights studying.



RATE ANALYST makes rounds of 11 cabinets checking on rate subsystems during countdowns. Besides hard work and ever-changing courses, missilemen face housing shortages at rapidly expanding Vandenberg.

handpicked for challenge . . .

CONTROL ROOMS, such as this one built for *Thor* training, enable all training operations on launching pads to be followed by training directors.

EACH TRAINEE, each training problem, is monitored on display boards.

Martin Co., the prime; **Avco Mfg. Co.** (re-entry vehicle); **American Machine & Foundry** (erector); **Bell Telephone Laboratories/Remington Rand** (guidance); **Aerojet-General Corp.** (propulsion).

Boeing Airplane Co., the prime for *Minuteman,* so far is running the only contractor school for this solid-fueled ICBM. Others are expected to start up later this year or early in 1961.

A missile training squadron—the 395th—has been activated here for the *Titan* program and work is well along on the equipping of an underground silo launcher where the first "molemen" will be trained.

• **Improvising**—For the whole ICBM training program officers frankly admit "we have to write and re-write the book as we go along." Improvements are continually being programmed into the bird, changing operational procedures, the manuals for maintenance and many times the number of men needed to operate the weapon.

The Air Force even has had to set up an entirely novel Directorate of Training to coordinate the program, which it calls "integrated weapons systems training."

Atlas Launch Crew

An *Atlas* launch crew today has evolved into a unit of 13 men. They include:

A launch control officer, missile system analyst, power distribution system technician, missile electrician, three missile maintenance technicians, a missile engine mechanic, ground support equipment specialist, propulsion system technician, guidance system analyst and hydraulics technician.

The crew for a radio inertial guidance unit is comprised of 18 men:

A guidance control officer, track analyst, track transmitter specialist, track receiver specialist, track data processing specialist, two track antenna servomechanism specialists, rate analyst, rate transmitter specialist, exercise analyst, exercise simulation specialist, exercise recorder specialist, digital computer analyst, digital computer systems specialist, digital computer electromechanical specialist.

In the all-inertial system the guidance crew has been reduced to just four men:

A guidance control officer, automatic tracking radar specialist, automatic tracking radar technician and electronic computer maintenance specialist.

The number of men in the launch section is not changed by the introduction of all-inertial guidance.

This directorate, a part of the 1st Missile Division and the only one in SAC, has four divisions: missile training, surveillance, standardization and collateral (supporting personnel). Contractor personnel and civilian construction and technical service people also operate under the directorate.

Today the pipeline for *Atlas* crews is full, and the selection and training for *Titan* missilemen is partially complete. Training for *Minuteman*—still two to three years away—is just getting organized.

Chosen for their brains and special skills, these crewmen are considered the "cream" of the Air Force. They have been plucked from SAC bomber crews all over the world; communications and maintenance outfits; from Tactical Air Command *Matador* and *Mace* missile squadrons; SAC command posts; the Pentagon; and even from the U.S. Naval Academy.

Most are seasoned and dedicated Air Force career men who look upon the ICBM not only as a necessary weapon in the Nation's arsenal, but as a personal challenge. Many feel this is but an interim evolution before once again they cut free from the earth —and head into space.

Indeed, Maj. Gen. David Wade, commander of the 1st Missile Division at Vandenberg, has said: "These vital (missile) programs . . . represent SAC's first step into the realm of space."

• **Training grind**—Selection of *Atlas* crews began in January, 1958. Thou-

sands of personnel records were screened and the men hand-picked. Now that they are in the program, practically every move they make is carefully watched. Their standard of performance has to be high or they are washed out.

Says Lt. Col. James B. Vogeler, Jr., chief of the missile training division in the Directorate of Training, "Training is just as important as the hardware itself. The people must be trained before you have a weapon system."

Training for the missileman is an all-consuming grind from beginning to end.

At Vandenberg, the classroom for the most part is the launching pad itself. Here the missileman puts what he has learned—and continues to learn—to the test. Here also the missileman is integrated into a crew that learns to work as a team and will be sent out to an operational squadron as a team.

The school day at Vandenberg is split into three shifts, each eight hours long. But the trainees often continue to work on problems at their pads long after their eight-hour day has ended.

About 85% of their time is devoted to training on equipment. Only 15% is for briefings, critiques of their work and procedural training.

This grind for *Atlas* crews lasts anywhere from two to 12 weeks depending on a missileman's job. Launch crews and guidance crews train for 12 weeks at Vandenberg alone. Re-entry vehicle men train for six weeks. Maintenance management men train for only two.

This does not include prior training at industry and ATC schools. For example, launch crew missilemen undergo two months of advance training before arriving at Vandenberg.

Present scheduling calls for graduating crews from Vandenberg in time for them to arrive at their operational launch pads to take part in the installation and checking out of its equipment.

As one training officer puts it: "Our missilemen will participate in building their own house."

Nor does training stop here.

• **A new breed**—Present plans call for continual proficiency training at the operational launching sites and the periodic return of crews to Vandenberg for retraining. Moreover, individual crew members will be brought back to Vandenberg from time to time to take part in actual launchings.

The end product is an entirely new kind of military man. The combat missileman is not only an operations man or only a maintenance man: He is both.

The problem of training such a military man would be very great under any circumstances. There are no guides; no textbooks; no long experience. This is why the whole training program is being fashioned from scratch. But this is only part of the problem.

The basic difficulty is that the missileman is being trained for a weapon that is continually evolving. Today's texts are old-hat tomorrow. Trainees complain that what they learned during their pre-Vandenberg lectures no longer applies to the equipment they find on the launching pads. Sometimes the equipment is being installed as they arrive.

This is no temporary situation the Air Force must live with. The nation's security demands that missilemen be trained while their missiles are still being developed and improved. This is true now of *Atlas*; it soon will be true of *Titan*; and still later it will be true of *Minuteman*.

• **How big a crew?**—The most glaring example of this is the size of an *Atlas* crew itself. No one can say today what will be the best size for the crews that will man *Atlases* two years from now.

Originally, an 18-man guidance crew and a 13-man launch crew fired the first operational *Atlas* from Vandenberg last September. The typical guidance crew now has been cut to four. Further reductions are expected.

This has already been the history of the *Thor*, which helped set the pattern for *Atlas*. Originally 12-man RAF crews fired one *Thor* in training here. Now three men can launch a single *Thor*.

Moreover, most of these changes in the size of crews have come about without the experience of having to man large numbers of missiles at widely dispersed sites. This is expected to bring about further changes in crew requirements.

• **"A lot to think about"**—The type of officers and men chosen for this pioneering assignment come from a wide variety of backgrounds—some technical, some not.

Col. John J. Easton, commander of the 576th Strategic Missile Squadron, which fired the first operational training *Atlas*, is a former chief of the Electronic Data Systems Planning Division and director of administrative services at SAC Headquarters. Technical Sgt. Bruce Pottoroff, a missile system analyst technician in Easton's squadron, is a 24-year-old high school graduate. Vandenberg is the only technical service school that he has even attended.

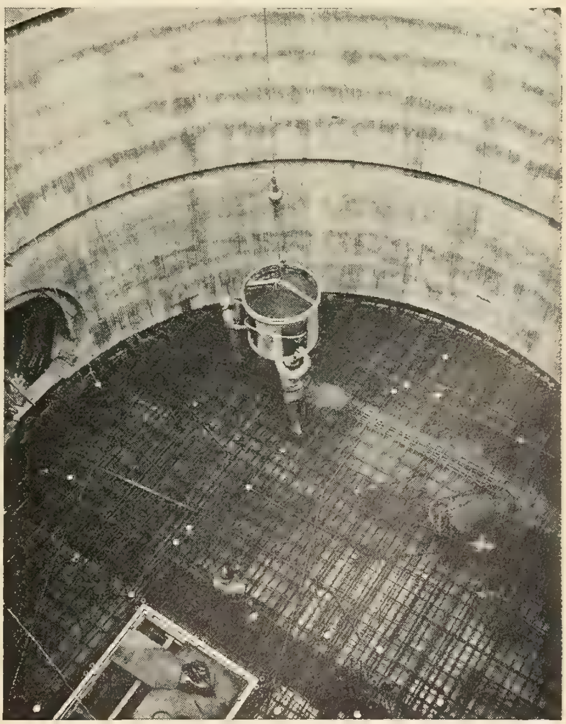
Enthusiasm and dedication among the trainees is extremely high.

Sgt. Donald Scearce, a 27-year-old missile system analyst technician who graduated from *Matadors* to *Atlases*, decribes his job as continually challenging.

"There's something new every day," he said. "They can send me anywhere as long as I stay with missiles."

Then there is another feeling—the feeling of awe for the job itself.

As Capt. Albert Ford, a 42-year-old launch control officer, put it: "There's a lot to think about when you have your finger on the button."



***TITAN* silo soon will have erection mechanism installed. Here Air Force will start on-site training of "molemen" late this year. Silo is 163 ft. deep.**

Vacuum Knowledge Is Slim But Growing

Unlimited pumping capacity of space is detrimental to most of the substances on earth; vacuum technology is being expanded to meet demand for test facilities

by John F. Judge

WASHINGTON—A sudden surge in the re-creation of the vacuum of outer space in large chambers is increasing the dimensions of an old market—environmental test facilities.

The demand for such equipment has been growing for several years, and the first chambers are now emerging from production lines. It is now possible to test the effects of ultrahigh vacuum on full-scale structures.

The surprising consequences of extremely low pressure on most of our common structural materials, and our meager knowledge in the area, generated this expansion in vacuum technology.

• **Vacuum consequences**—The vacuum effects on materials can be considered under two general categories.

The first is the evaporation of the substance itself, or of a volatile component. Briefly then, the usefulness of a material is a function of its vacuum vaporization coefficient.

In essence, molecules leaving the surface do not have the opportunity of collision that exists in the presence of an atmosphere, which would return them to the surface.

Such molecules may be considered as lost. In space, unlimited "pumping capacity" insures the continual sublimation of an exposed solid surface.

The second general effect is the removal, total or partial, of the absorbed surface gas layer which covers all materials under sea-level conditions.

The result is all out of proportion to the material change involved. Such things as creep-rupture time and friction in metals are known to be significantly changed. There are other subtle effects.

Considering the "hard" vacuum of space alone, apart from the aspects of temperature, radiation and micrometeorite impact, a host of problems are immediately apparent.

The essential points to remember are (1) the important effects are produced long before appreciable quantities of a material evaporate or sublime, and (2) the time of exposure.

Mechanical properties are affected by the atmosphere in which the determination was made. Dr. M. R. Achter of the **Naval Research Laboratory's High Temperature Alloys Branch** has explored creep-rupture and fatigue behavior of alloys at high temperatures. In a report presented to the Sagamore Conference on Space Materials, the Navy scientist said that at high stresses and lower temperatures, creep-rupture lives were longer in vacuum than in air.

But he found the reverse happening at lower stresses and higher temperatures. The proposed mechanism involved two competing processes, strengthening by oxidation and strength reduction due to the lowering of the surface energy.

N. J. Wadsworth and J. Hutchings have shown that the density of a surrounding gas affects the fatigue life of certain metals.

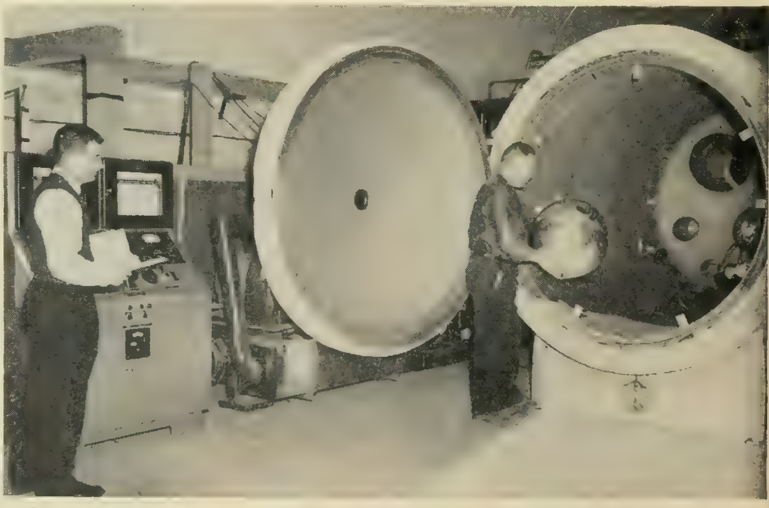
The second general phenomenon, that of the removal or formation of the absorbed gas layer, is believed to be involved in both operations.

Reduction of surface sublimation from metals and alloys may be accomplished through coatings of inorganic oxides. Still, there are indications that there are other, more complex effects in this area.

Plastics face a rougher future in space. Because of their organic nature, they have higher vapor pressures and consequently sublime much more readily than metals or other inorganics. Plastics formed from the polymerization of pure materials fare somewhat better than those employing a plasticizer. Silicone polymers are in a class by themselves in vacuum endurance.

• **Lubrication**—The problem of lubrication in the hard vacuum of space has top priority. Conventional lubricants disappear in short order and the clean surfaces remaining will quickly seize or weld together.

Solid lubricants have their short-



TEST CHAMBER at Army's Signal Research and Development Laboratory, Fort Monmouth, N.J., duplicates near-vacuum conditions found 100 miles above the earth.

comings. The most familiar, graphite, is useless because it depends upon trapped water vapor for its lubricity. Molybdenum disilicide seems to offer some promise but there is the question of bonding. And there is always the time factor.

Silver plating is another method of providing a friction-reducing surface, but the process is difficult and expensive. There are many companies interested in both short- and long-term vacuum lubrication. This is a good indication that the idea of hermetically sealing all motors and moving parts involves bigger problems than development of good vacuum lubricants. This is in addition to the obvious weight considerations encountered in such encapsulation.

• **Some benefits**—Another consideration is in the vacuum effect on overall structures. Designers have always allowed for atmospheric damping on vibrating structures.

Professor B. J. Lazan, head of the Department of Aeronautical Engineering of the University of Minnesota, explained that atmospheric damping is difficult to describe without accounting for other energy dissipation effects within a structure.

The absence of an atmosphere introduces many complex problems, to be sure; but the scientist pointed out that flutter, some acoustical fatigue, and other aeroelastic excitations disappear in a vacuum.

This "mixed blessing" occurs in other areas in vacuum environments. The absence of oxygen has its beneficial effects on materials as does the lack of other gases and vapors commonly present in our atmosphere.

The absence of gravity is one more credit factor in material applications. Gears and bearings will be loaded primarily by the torque or force they must transmit to overcome inertia, and by their own frictional drag. Of course, additional problems of lubrication exist, but some conditions are improved because of the vacuum.

How does one go about learning more of the physical aspects of a vacuum?

It is fairly obvious that laboratories are not going to be hurled into space in the near future. Probes and instrumented satellites can and do supply a great deal of information but there is a basic limitation involved.

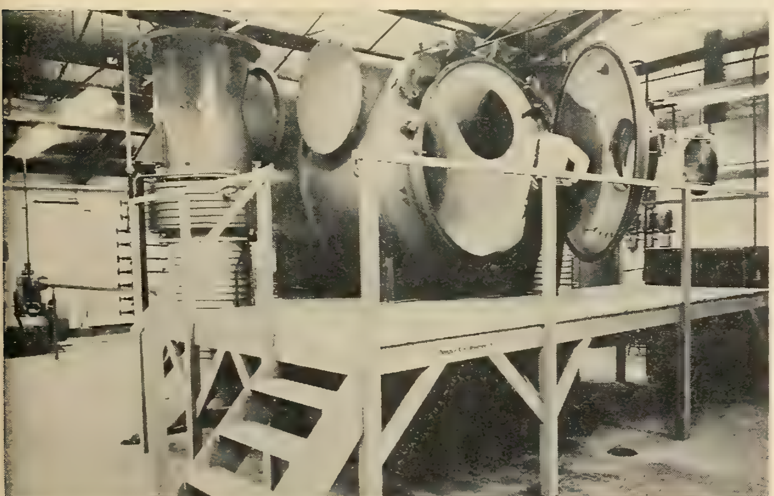
This drawback stems from a cardinal rule in the gathering and interpreting of scientific data—that of successfully isolating or controlling variables in order to trace the results accurately to an originating stimuli.

To instrument a satellite to provide this type of service would be extraordinarily expensive and actually unjustifiable if there are other means to provide the necessary answers.

• **Environmental testing**—The immediate problem confronting us is the effect on available materials of the environment in the region extending several hundred thousand miles from the earth. This involves primarily the question of "how" not "why." But reaching this immediate objective may very well involve a great deal of basic fundamental theory.

This basic work can best be done on earth in environmental test chambers.

The task of bringing the vacuum of outer space into the laboratory is less difficult than it might superficially seem. While the density-equivalent pressures in space are thought to be in the area between 10^{-11} and 10^{-15} mm mercury or lower, for many purposes the simulated vacuum need not be anywhere near this.



CHAMBER built by NRC Equipment for Ramo Wooldridge can provide a vacuum of about 10^{-5} mm Hg in one hour. It's designed for general and ion engine testing.

Radiant heat transfer studies might be made under conditions much less stringent than those necessary for certain friction data.

• **Vacuum chambers**—The recent history of vacuum chambers is that of a constant search for larger vessels with higher pumping capacity. The production of high vacuums (10^{-7} mm Hg) has been readily possible for many years. A typical high-vacuum system involves a backing pump; a water vapor collector, to prevent water from entering the back up pump; a diffusion pump; a cold trap, to prevent vapor from the diffusion pump from entering the vessel; and finally, the evacuated vessel.

After the physical plant is provided, certain procedures and methods are followed to insure successful operation. There can be no leakage to the outside atmosphere, and only low-vapor-pressure oils and greases are used in lubricating and sealing the system. Gases absorbed on the walls of the system are removed to a certain extent by "bake-out"—heating the entire system as much as possible while operating the pumps.

For most applications, the above system is sufficient. But in simulating outer space to determine effects on materials, more sophisticated and complex systems are necessary. Investigators at the University of Illinois recently reported that samples under study in a standard vacuum apparatus of 10^{-6} and 10^{-7} mm Hg capacity became surface-contaminated with foreign matter in 20 minutes. This contamination was enough to halt the experiment. When the scientists used special systems which maintained a vacuum of at least 10^{-10} mm Hg, there was more than a thousandfold improvement.

The Illinois scientists suggested that air contamination of some surfaces is important even in the best standard vacuums.

The investigators pointed out that much of the present information on the surfaces of solids may be of little scientific value.

They said practical data on the nature of "clean" surfaces may be so limited as to prove dangerous when space flight is attempted. This is presumably based on the assumption that much of the work carried out in high vacuums has been extrapolated into the ultrahigh-vacuum area for comparison purposes. While the investigation of "clean" surfaces is admittedly more involved with the kinetics of surfaces, and is difficult to perform unless extremely efficient vacuums are em-

ployed, the fact that contamination existed where none was expected might lead one to examine earlier results in other areas more closely. The same vacuum level or less was probably maintained when other effects were under study.

• **Evacuation techniques**—The actual pumping equipment is not the whole story of evacuation. At extremely low pressures evacuation is a function of the design of the entire system—including outgassing and surface absorption effects.

Only a few representative pumping techniques will be described here since the field is extremely large and complex.

• Diffusion—Based on the concept of Langmuir, diffusion pumps fundamentally involve the capturing and removal of gas in the evacuated chambers by a flowing vapor stream. Molecules of the gas to be removed usually enter the pump by random thermal motion.

Theoretically capable of pressures to 10^{-10} mm Hg, diffusion pumps contaminate ultrahigh-vacuum systems. Better oils and the incorporation of other techniques reduce this tendency.

• Getter pumps—The familiar use of getters is in the final exhaustion of lamp bulbs. High-vacuum getters such as barium and titanium are in present use. Other materials fit special applications. Since a chemical reaction is involved, getters have no effect on the inert gases.

• Electronic Pumping—This technique involves using electromagnetic forces to move gas particles. The high equipment cost and the necessary special power supply are inherent disadvantages.

• Ion—Gettering pumps—A combination of electronic and getter pumping, this system eliminates some of the disadvantages of each but produces some new ones. It is not too effective on inert gases and requires complex controls, reducing operational reliability.

• Mechanical pumps—Evacuate by imparting high directional speed to gas molecules by impact on a high-speed surface. Although capable of producing clean vacuums, these pumps present the usual difficulties of fast-moving machinery.

The utilization of cold traps, condensation and absorption techniques in combination with the above systems, or in other methods, is possible. But space does not permit a thorough evaluation of their applications here.

• **Measuring the vacuum**—Accurately determining the pressure of a chamber below 10^{-7} mm Hg is a complex task. A wide variety of gauges available, and the subject is too broad and comprehensive to detail here.

The problem is not only the presence of residual gas, but also its nature and chemical makeup. To provide even more complexity, some gauges also act as pumps.

On the other hand, measuring systems have been developed for special applications that are so sensitive that the leakage of helium from the air into the system through its glass walls produced an appreciable rise in pressure.

Vacuum gauges fall into four general groups—Mechanical, Liquid Manometer, Heat Conductivity and Ionization.

Some of the firms involved in their production are **Consolidated Electrodynamics Corp., Vecco Vacuum Corp., NRC Equipment Corp.** and **Lebold,** a German firm.

The subtle and far-reaching effects of the space vacuum on materials are but vaguely understood. The main obstacle has been the fabrication of suitable facilities. Indications are that this barrier is rapidly falling and the research being conducted at such firms as the **National Research Corp, Jet Propulsion Labs, Space Technology Labs, Lockheed Aircraft, The Martin Company, Convair, Astravac Corp** and many others will clarify the list of man's space-compatible materials.

Pack Pressing Makes Better Domes

COATESVILLE, PA. — Solid-rocket motor casing domes are pounded into shape by a novel fabricating technique —"hot pack pressing."

Created by the **Lukens Steel Co.,** the method produces extreme uniformity of thickness and freedom from decarburization, and eliminates heat scale.

In pack pressing, a disk of high-strength alloy sheet is sandwiched between two circular plates of mild steel, after being sprayed with a parting compound. The coating substance is intended to prevent metal-to-metal contact during the forming; it also acts as a high-temperature lubricant.

The cover diameters are identical to each other but slightly larger than the dome disc. The covers are welded together around the edges except for a small vent hole which releases trapped air and gases during heating.

This "pack" is heated to around 1600°F and placed on a hydraulic drawing press. The dies are compound. A ring-type hold-down is fastened to the main press platen. A central ram in the platen mounts a secondary cylinder to which is fixed the contoured punch.

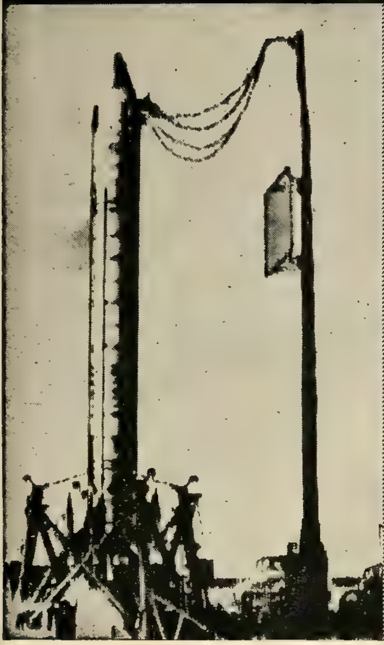
Actual drawing is carried out in a series of steps with a reheating of the pack following each phase. This is necessary because the alloys are sensitive and must be maintained in a narrow temperature range. After the final pressing, the pack is allowed to cool, the welded edge is trimmed off and the covers are separated.

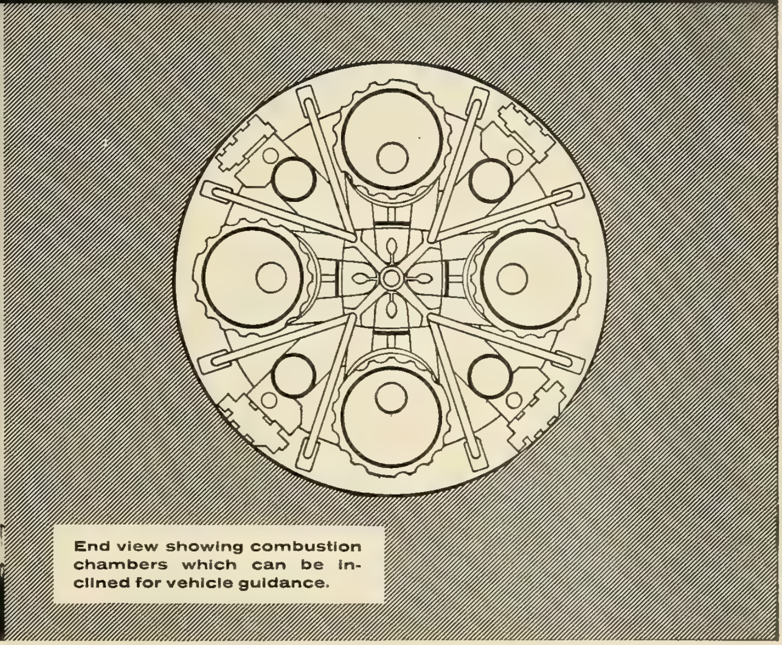
The process is flexible and can be applied to many materials, including beta titanium. The same tooling can be used to press heads of dissimilar gauge —in one case from 0.060" up to 0.300".

There are no special requirements in choosing cover plates, other than that they be amenable to hot pressing and have fairly smooth surfaces. The exact pressing cycle is governed by the characteristics of the material involved, as is the physical strength to which the finished head may be heat-treated.

STRIPPING of top cover from finished dome shows the scale-free edge of the dome and (below its visible edge) clean appearance of bottom cover.

Gamma rocket engine delivers 19,000-lb thrust outside the earth's atmosphere–for a weight of under 700lb . . .





End view showing combustion chambers which can be inclined for vehicle guidance.

...ANOTHER ENGINEERING ADVANCE BY BRISTOL SIDDELEY

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellent rocket engine, the Gamma delivers 16,400-lb thrust (7,438 kg) at sea level rising to 19,000 lb (8,618 kg) outside the earth's atmosphere for a total engine bay weight of under 700 lb.

The Bristol Siddeley Gamma has four gimbal-mounted combustion chambers which are hydraulically actuated for vehicle guidance. Each combustion chamber is fed with propellents by its own turbopump unit and the four units are joined at the centre by a common manifold. The Gamma burns hydrogen peroxide (HTP) with kerosene and uses silver-plated nickel gauze as a catalyst to decompose the HTP into oxygen and superheated steam.

Gamma powers Black Knight

The Bristol Siddeley Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. The Gamma has proved itself to be exceptionally reliable. In fact, in all firings to date Black Knight has never failed to start, and has reached a height of over 500 miles above the Woomera rocket range in Australia.

Since Bristol Siddeley's rocket division began work in 1946 it has developed a wide range of rocket components. By combining these components in single or multi-chamber layouts, thrust requirements from 500 lb up to very high figures, can be met.

BRISTOL SIDDELEY ENGINES LIMITED

BRISTOL AERO-INDUSTRIES LIMITED, 200 INTERNATIONAL AVIATION BUILDING, MONTREAL 3, CANADA

Circle No. 2 on Subscriber Service Card.

Breakthroughs on Transducer Front

Since M/R's October list of urgently needed developments, manufacturers have revealed answers to some problems and progress on others

by Charles D. LaFond

WASHINGTON—Long-awaited transducer breakthroughs have been revealed which will have great impact on the missile industry. Among these are digital-output transducers and 5-volt dc direct-output pickups.

The rapid advances in transducer development reflect the phenomenal growth of this important part of the industry. Only two months ago (Oct. 12 issue), M/R published a roundup of this market and detailed four principal problem areas. All have since been solved to some extent and researchers indicate that complete solutions are near at hand.

(Indicative of the growth in transducer application is the recent announcement by the Instrument Society of America that it has initiated a program to prepare and publish regularly a "comprehensive compendium of up-to-date information on all known transducers." The ISA also intends to provide a current bibliography of source material and a listing of manufacturers. Publication of the first volume is due in January 1961. The program is the result of a two-year ISA study.)

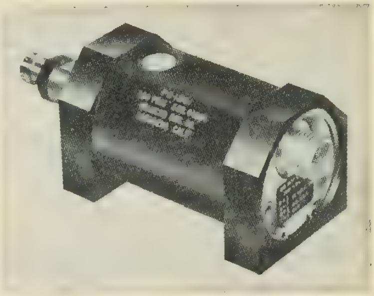
The four problem areas indicated by the M/R survey concerned the much-needed development of:

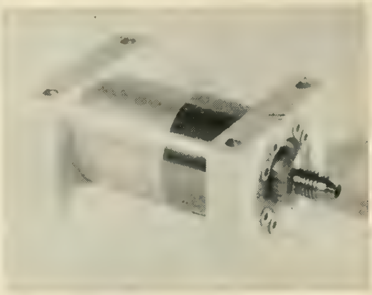
- A digital-output transducer for test use.
- A 2 to 5-volt high-output strain-gage transducer for direct coupling to telemetering subcarrier without amplification.
- A feedback potentiometer for operation in 1000°F environments.
- Vastly improved magnet wire, lead wire, and potting compounds.

The extent to which these problems have been solved can be described only within the tight limits of military security and company proprietary restrictions. Several of these devices are currently in use on major weapon systems.

NEW TRANSDUCERS

Two digital-output transducers have been developed and tested for a myriad of applications by **BJ Electronics Division** of **Borg-Warner Corp.** Until recently, both types have been under security wraps; even now, only one can be described.





TWO 5-VOLT DC output variable reluctance pressure transducers: above, type P2-1201 unit by Wiancko Engineering Co.; below, model CP-40 pickup by PACE Engineering Company.

This is a miniature, rugged high-precision pickup which uses a vibrating wire as its principal component. Output is a frequency modulated signal, eliminating the need for conversion from analog voltages.

Called a Vibrotron Transducer, the device has performed successfully in extended use on *Atlas, Redstone,* and other missiles. Essentially, it consists of a tightly-stretched wire (force equivalent to 200,000 psi) anchored securely at one end and terminating on the other end at a highly sensitive moving diaphragm. Changing the position of the diaphragm alters the natural frequency of the wire—much as tuning a violin string modifies its pitch.

When the device is used as a pressure sensor, a similar technique is applied. A short non-magnetic wire is secured in the field of a permanent magnet. Transverse vibrations are induced by an oscillator circuit attached to the wire.

As long as the current through the wire is at a frequency other than the natural frequency of the span of wire, a relatively constant impedance exists in the wire—that is, it is practically a pure resistance. But as the natural frequency of the wire length is approached the impedance changes rapidly. At the exact natural wire frequency, a phase shift occurs and the wire suspension becomes a resonator.

Successful operation from 3 to 25 kc has been demonstrated under severe environments.

A few of the applications of the Vibrotron Transducer, according to the company, include the measurement of acceleration, flow-rate, force, torque, and velocity.

At least two manufacturers are now producing 0-5 v dc direct-output transducers.

The **Wiancko Engineering Co.'s** dc pressure transducer is a variable-reluctance pickup combined with a solid-state carrier oscillator and ring demodulator. It was developed for telemetering, static test stand, and data systems; gage, absolute, and differential models are available.

Standard units operate in a temperature range from −65° to 165°F, but Wiancko says this can be extended to 250°F. Response to vibration is less than 1% error for 25 g up to 2 kc. The units, weighing about 11 ounces, will withstand shock up to 50 g without damage, and pressure ranges are available up to 10,000 psig.

PACE Engineering Co. has produced similar units using a dc-energized carrier-demodulator. Its variable reluctance transducers deliver 0-5 v dc, full scale. Input voltage (25-30 v dc) is regulated.

The 18-ounce units are stable in a temperative range of from –65° to 180°F and will withstand 35 g from 50 to 2000 cps. Stability is ± ½% over an 8-hour operating period. Pressure ranges are available from 5 to 1500 psi in gage, absolute, and differential models.

Consolidated Electrodynamics Corp. has developed two pressure transducers for continuous operation at 700°F without cooling. These are unbonded strain-gage types and together cover a range from 15 to 5000 psi. With a special cooling adapter, one of these (operating in the higher pressure range) can be modified for operation up to 2000°F.

To meet the extreme environmental conditions to which the **North American** *Hound Dog* air-to-surface missile is exposed, CEC produced a potentiometer transducer to withstand 10 g for sustained periods and at vibration frequencies up to 2 kc. Temperature range of the pickup is –65° to a 300°F maximum. Maximum static acceleration or shock is 100 g in any axis. Response to static acceleration is less than 0.01%/g.

Transducers now in advanced development at CEC include:

- A highly stable pressure pickup designed for rocket test stand use. Range extends above 700°F at pressures from 0 to 10,000 psi. Sensitivity can be adjusted and bridge unbalance set to better than ± 1%.
- Using refractory metals (instead of noble metal alloy) with stable electrical and mechanical properties, strain gage transducers for use in temperatures up to 1000°F. Part of this program is the development of a helium leak-tight feed-through seal for use at 1000°F, which will permit wider selection of strain wires.

A new 2.2-ounce gage pressure transducer for telemetering is now available from **Bourns, Inc.** The miniature potentiometer unit uses a Bourdon tube as the pressure sensing element. Pressures ranges through 5000 psig are available. Units feature low hysteresis, small temperature and vibration error up to 212°F and 5 g from 10-1000 cps.

Pacific Electro-Kinetics has developed a new linear, variable, differential-transformer transducer for temperature sensing. The ½-inch dia. probe is available in various lengths up to 17 inches.

Operating in a temperature range from –100°F to 350°F, input voltages may vary from 6.3 to 24 volts, depending on model.

A 6-ounce infinite-resolution pressure transducer is now available from **White Avionics Corp.** for control, telemetry and propulsion systems. A potentiometertype pickup, it will withstand 50 g at a 3-kc vibration frequency. Pressure ranges are 0-15 to 0-300 psi.

MAGNET WIRE

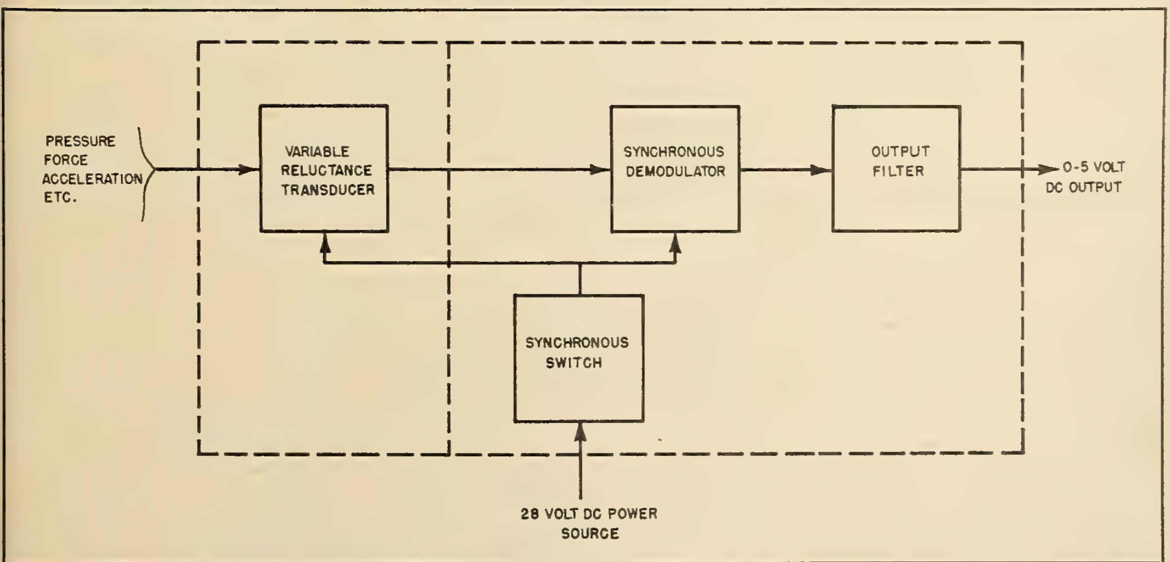
Efforts by industry to develop better insulated magnet wire have been intense in the past five years. Environmental requirements for devices employing magnet wire are not only demanding; they are constantly increasing throughout the missile industry. Application for these products is broad in the transducer field. A look at some current research and development will show progress to date and who is performing the work:

- **Epoxy enamel**—A broad range of epoxy-resin enamel magnet wire has been produced by **Anaconda Wire and Cable Co.** For use in moderately high temperatures (up to 400°F), the company line now extends over all wire sizes—round, square, and rectangular cross-section. Tests have shown it will withstand severe thermal shock, provides good chemical stability, and is compatible with other insulations.

In its manufacture, epoxy enamel has the characteristics of good reproducibility, coating ability, and long storage life.

Furane Plastics, Inc. also has proven long-time (500 hours) thermal stability of epoxy enamel at temperatures up to 400°F. For short-time use in missiles and rockets, maximum operating temperature is considerably higher, according to company researchers.

- **Teflon**—For very high temperatures, tests by **I. E. du Pont de Nemours & Co.** and the Navy's Bureau of Ships have shown that Teflon TFE- and FEP - Fluorocarbon resins provide necessary characteristics for wire insulation at temperatures of 842°F and above. Different types and sizes of wire have been investigated with equal success.
- **Pigmented polyester**—At the **Westinghouse Research Laboratories,** researchers have been investigating pigmented polyester magnet wire for use in temperatures up to 1000°F. Very satisfactory performance has been ob-



Block diagram of the Wiancko variable-reluctance dc transducer.

tained at 600°F, and short-term success has been achieved above 1000°F. To test thermal shock, units have been exposed to a cycling from -65°F to 600°F. Results have been satisfactory, but tests are still in progress.

• **Ceramics**—Ceroc HT and Ceroc ST, also by du Pont, are ceramic coatings cemented to wire by the action of silica and alumina gel. The former provides adequate performance up to 482°F; the latter is good up to 572°F.

Georgia Institute of Technology has been working since 1953 in ceramic research. In 1957, under an Air Force contract, it participated in a program to develop an insulation for use from -85°F to 1500°F. All other desired characteristics were similarly rigid including a 10,000-hr. life expectancy.

The required insulation has been found by using aluminum oxide, provided by anodizing aluminum coated copper wire. For repeated use in temperatures at 1500°F, either a ceramic organic coating or colloidal silica are used as sealers.

• **Strip windings—Aluminum Co. of America** has been developing aluminum wide-strip windings for electromagnetic devices. The idea is not new, but many production problems had to be solved to make its use economically attractive.

Thinner insulations can be used to permit higher space factors (70-95%). Since there are no buried turns, inner hot spots are avoided. Another great advantage, according to Alcoa, is the labor saving resulting from automation.

• **Encapsulants**—This is a tough research area. So far it looks as though no single matrial provides all the needed characteristics.

There are some problems with epoxy resins, but they, too, vary with the particular compound. Many have been found which provide high dielectric strength (sometimes even increased strength) at temperatures up to 450°F on a long-time basis. **Epoxylite Corp.** has made advances, but intense research is still in progress.

Bell Telephone Laboratories, Inc. has performed comprehensive tests on alumina powder as a potting material. Results have shown many advantages in its use: it withstands temperatures above 1800°F, does not expand or contract with wide temperature excursions, does not cure or vulcanize, is light in weight and low in cost.

Dielectric gel, a silicone potting compound, developed by **Dow Corning,** has several advantages, particularly for encapulating coils and other windings. It offers very high insulation resistance, low stress, and high resistance to physical shock. Tests have indicated at least 1000-hr. life at temperatures around 400°F.

Bunker Takes Over *Titan*

BALTIMORE—In an additional move to strengthen management of the *Titan* program, **Martin Company** announced this week that all aspects of the project are being consolidated into a single integrated division with headquarters at the Denver plant where the missile is being built.

MISSILES AND ROCKETS on December 28 reported that the firm would tighten liaison between various divisions working on the program, but the company denied that such a change had been ordered by the Air Force.

George M. Bunker, Chairman of the Board, on January 4 will assume the title of general manager of the *Titan* program and will take personal charge of integrating and coordinating the production, testing and launch activities. H. W. Merrill will be vice president and assistant general manager of the overall program under Bunker.

The recently organized *Titan* base activation division, headquartered in Denver, will be incorporated in the new organization with its present head, V. R. Rawlings, serving as manager of this phase of the *Titan* project. Also included in the new set up will be all *Titan* pre-flight and launching activities at Cape Canaveral.

In announcing the integration, Bunker said development of the *Titan* has now reached the stage where "we are convinced that, with a proper concentration of effort on our part, 1960 will go down in Air Force annals as 'the year of the *Titan*' and that this 'second generation' ICBM also will establish a firm place for itself in the nation's burgeoning space program."

Air Force and **Space Technology Laboratories** (M/R, Dec. 21, p. 43) completed a re-evaluation of the program and pronounced it technically sound, but questioned Martin management.

Fiberglas Blocks Cut Weight of Nuclear Shields

WASHINGTON—Nuclear shielding systems that eliminate the need for the handling of heavy materials have been developed by the **General Nuclear Corporation.**

The shielding is composed of hollow fiberglas blocks, which are filled with lead, water or concrete to provide the specific type of protection required. Stanley H. Clark, president of the firm, explained that virtually any shielding substance can be incorporated into the fillable, interlocking blocks.

Before filling, the blocks are lightweight and consist of two basic and three compound sizes. Each part of a compound block can be filled separately.

Microwave System Adds To Mobility of Antennas

MILLIS, MASS.—Development of a mobile, microwave, passive-reflector system that eliminates the necessity of rigidly-fixed booster stations was revealed by the Electronics Division of **The Gabriel Company.** The "pie-plate"-shaped reflectors redirect microwave energy in almost any desired direction, the company says.

In conventional reflector systems, the passive reflector is used to change direction of transmitted microwave energy from vertical to horizontal, and vice-versa, with a paraboloidal-reflector antenna located directly below the reflector.

The new system permits location of the transmitting antenna anywhere within 1200 feet of the passive reflector, according to Gabriel. Obvious advantages are that reflectors can be easily located and serviced in formerly inaccessible areas, and the microwave system can be aligned by positioning either the paraboloidal antenna on the ground or the passive reflector aloft.

NRL Process Prevents Columbium Oxidation

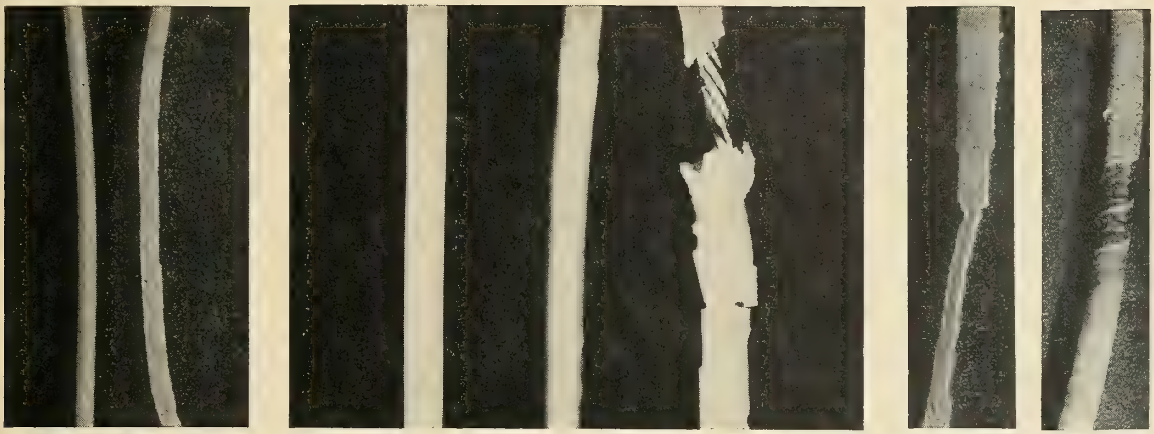
WASHINGTON—A self-healing, heat resistant metal coating has been developed by the Naval Research Laboratory. The process is designed to prevent the oxidation of columbium.

Tests have shown that alloys of columbium can retain their characteristics at temperatures up to 2,200°F in an oxygen environment if coated by the NRL process. Columbium ordinarily crumbles to dust when exposed to oxygen at these temperatures.

Based on zinc, the coating actually forms an alloy with the columbium. At high temperatures, zinc is released, forming a protective "envelope" on the surface of the part. It rapidly repairs flaws and is plastic, preventing bare spots from developing when the base metal is subjected to stresses.

The usual coating procedures can be utilized. Industry is currently evaluating the process to determine its practicality in high temperature component fabrication.

Tests Point to Higher Teflon Range



INSULATION resistance of Teflon coverings remained in the megohm range at high temperatures until thickness was sufficiently reduced by decomposition. Photo at left shows Sample 1a before and after test. Despite some thermal erosion, coating integrity was still maintained after ten minutes at 454°C. Insulation was maintained for more than 30 seconds (center); did not decompose until after 60 seconds (right). Photos at far right show construction of Sample 2 and results of 4½-minute exposure at 538°C. Slight thermal expansion is indicated by dark area.

WILMINGTON, DEL.—Acceptable operating temperatures of Teflon electrical insulation may be considerably extended thanks to testing recently completed at **DuPont's** Polychemicals Department here.

The tests were conducted to re-evaluate the ability of the TFE-fluorocarbon resins to withstand the constantly increasing requirements for higher-temperature environments in missile and aircraft applications. Present recommended continuous service limitation of 260°C (500°F) has precluded use of this plastic in many instances where its many desirable characteristics made it preferable to other coverings.

Findings show that insulation resistance remains within usually acceptable limits (50 megohms/1000 ft.) until decomposition of the covering takes place. Some samples held up for several minutes at temperatures of 538°C (1000°F). Results differed according to type and configuration of insulation, temperature rise rate, peak temperature, and exposure time.

Basic conclusion reached by DuPont Researchers H. B. Barrett and J. C. Reed, was that the insulation resistance of Teflon remains in the megohm range even at temperatures much above the transition temperature (327°C, where the resins change from a crystalline to an amorphous state). They also found that the resins retain an appreciable degree of elastic strength equivalent to a high-modulus rubber, a fact not generally known.

The DuPont tests consisted of a series of electrical resistance measurements made at temperatures from 300 to 650°C (572 to 1202°F). They covered the insulating properties of the TFE-resins used as wire insulation conforming to specifications of MIL-W-16878 Type E and MIL-W-7139. Samples used were randomly selected from commercial material. They included:

Sample 1a—MIL-W-16878 Type E AWG #22 (7/30 stranded) silver-plated copper wire with 10 mils Teflon 6 insulation.

Sample 1b—Same as 1a except nickel-plated copper conductor.

Sample 1c—Four strands AWG #30 solid platinum wire inserted in a tube of 10-mil wall thickness Teflon 6.

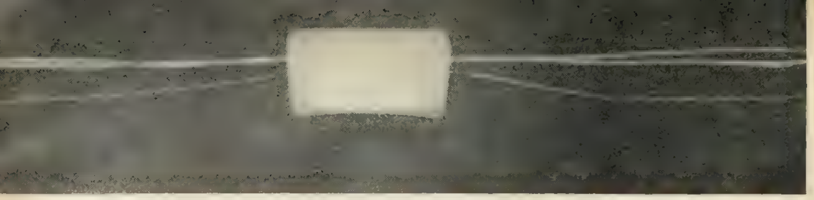
Sample 2—MIL-W-7139 AWG #22 (7/30 stranded) silver-plated copper wire with 19 mils Teflon 6 insulation covered with 9 mils glass serving impregnated with Teflon 30 in turn covered by 10-mil glass braid impregnated with Teflon 30.

Sample 3—AWG #18 (19/30 stranded) silver-plated copper conductors with 16 mils Teflon 6 insulation (MIL-W-16878 Type EE). (Six of these wires were covered with a 30-mil jacket of Teflon 6 to form a cable.)

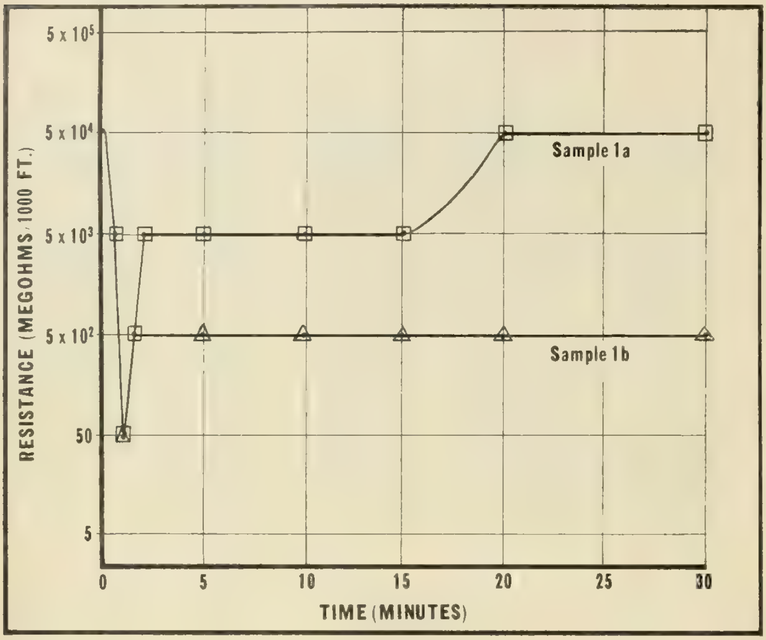
Sample 4—Two 0.020-in. diameter platinum wires spaced 0.020 in apart in a cylinder of Teflon 7.

• **Test procedure**—Resistance checks were run with two-foot samples of the insulated conductor wrapped in aluminum foil and placed in an electric furnace. The foil served as a ground for leakage current measurements. The conductor, carrying a test voltage of 500 vdc, was kept at the prescribed temperature for 30 minutes, or until the insulation broke down and the circuit shorted.

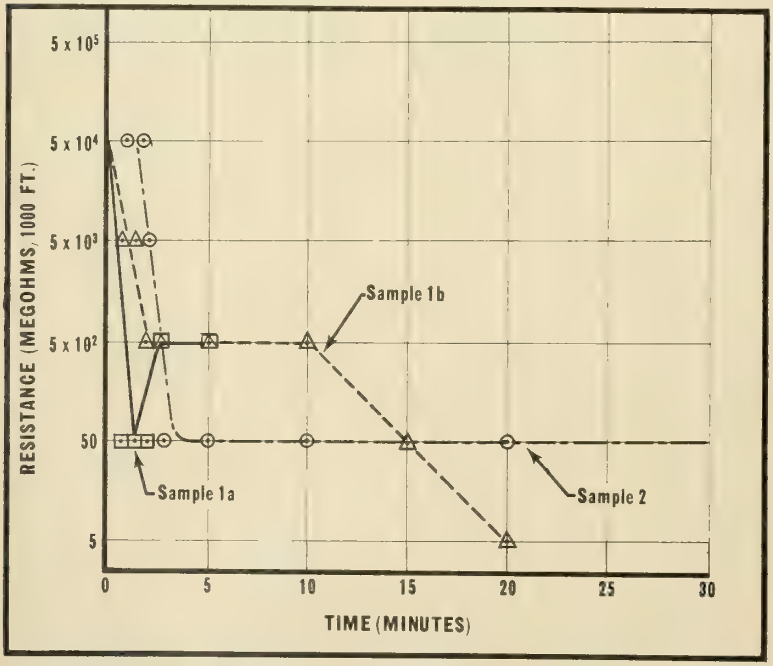
Measurements were also made with the same setup under a constant temperature rise of 10°C/minute. Beginning at 200°C, the conductor ambient was raised until the sample shorted.



CYLINDER of Teflon 7 kept shape after almost two minutes in gas flame. Insulation provided high resistance for three minutes at temperatures up to 519° C.



TESTS AT 400° C and 500 vdc show good resistance even beyond 30 minutes.



AT 500° C, Sample 1a shorted at 8 min.; 1b at 22 min. Sample 2 lasted for 45 min., when the thickness of the insulation was materially reduced by decomposition.

In a third series, a molded cylinder of Teflon 7 containing two lead wires—separated by 0.02 in. of insulation—and a thermocouple was held in a gas flame until one of the leads shorted.

Values for insulation resistance were computed from the leakage currents obtained and converted to megohms per 1000 feet, as generally required by specifications.

• **Results**—Most test samples showed a characteristic initial decrease in resistance within a 2-3 minute period from the start of the test, as shown in accompanying graphs. This decrease was usually followed by a partially—and sometimes completely—restored equilibrium value, except at 500°C.

The reason for this decrease could not be completely explained by the researchers. The most acceptable theory advanced to account for the phenomenon was that some conductive volatiles accumulated on the insulation or evolved through it during pre-test exposure at room ambient. Evolution of the suspect volatiles appeared to be complete after the 2-3-minute period and equilibrium attained. The fact that the equilibrium resistances were different for the various samples was explained as an indication of different levels of ambient pickup of conductive volatiles due to non-standardized preconditioning procedures.

In general, the significant results of the tests indicated that Teflon-insulated conductors could be successfully used for short periods at temperatures far exceeding standard specifications. These new findings could prove particularly valuable in missile applications where short-duration temperature extremes are likely to be encountered.

• **Navy tests**—In a parallel research program conducted by DuPont for Bureau of Ships, Teflon also showed up well for use at high temperatures. This work—described at the recent National Conference on Electrical Insulation by J. J. Casey, Bureau of Ships, and J. P. Shoffner, DuPont—compared the high-temperature performance of Teflon TFE- and FEP-resins with other insulation materials. Results showed Teflon superior in many respects.

Primary objective of the tests was to determine the thermal life of representative materials. Standard hookup and interconnecting wire constructions were exposed to temperatures ranging from 200 to 500°C for periods up to 500 hours. After thermal aging, samples were electrically tested for failure by a high-pot dielectric test. A sample passing the dielectric test was returned to the oven for continued high-temperature aging and retested periodically to determine life expectancy at the higher temperatures.

A significant fact, noted by the authors, is that test voltages used (twice rated plus 1000 volts) were those specified by MIL-W-16878 for unaged wire. Consequently, the level of acceptance was appreciably higher than required by existing military specifications and the resultant data proportionally conservative.

Representative samples of the most widely used airborne electrical insulations were used in the tests: polyvinylchloride, monochlorotrifluoro-ethylene, silicone rubber, and Teflon TFE- and FEP-fluorocarbon resins.

Three series of tests were conducted based on cyclic performance in combinations of 1) heat aging, 2) heat aging with modified NAS-703 bend test, and 3) modified NAS-703 heat resistance test. The MIL-W-16878 dielectric strength test for unaged wire served as the measure of acceptability or rejection following each conditioning cycle. A minimum of 10 samples of each construction were sampled.

• **Conclusions**—Briefly, the conclusions advanced by the Casey-Shoffner paper are these:

(1) Teflon wire insulation can be specified for short-term exposure at 400°C with a life expectancy of 60 hours and for higher temperatures with proportionately shorter life.

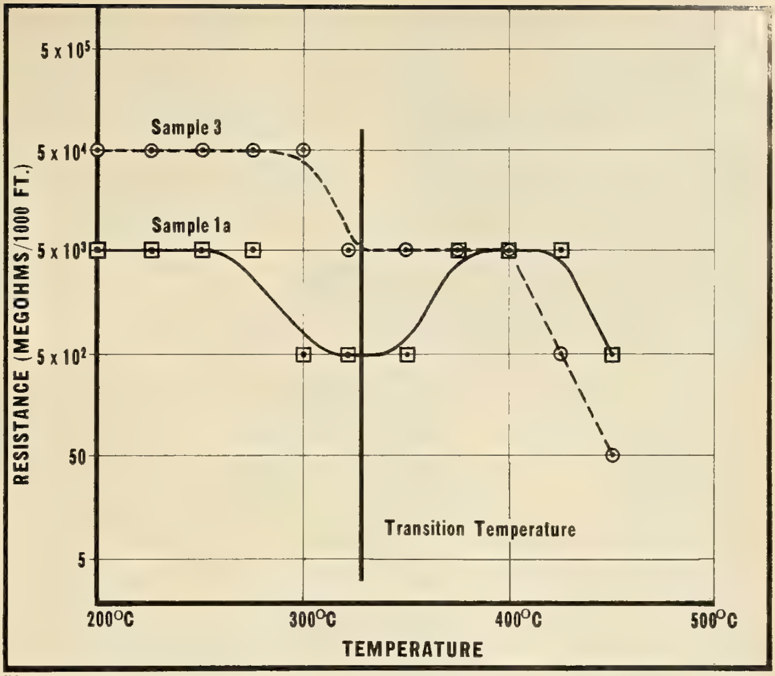
(2) Teflon can be specified for continuous rating in the 250-300°C range in lieu of the current 200°C limitation specified by MIL-W-16878 for prolonged service.

(3) These data, and independent BuShips evaluation, indicate that Teflon 100X FEP resins will meet MIL-W-16878 requirements of Type E and EE wire. Plans are to include this resin in the specification as the existing Type E and EE constructions and uprate the TFE resins from their present position. A new letter designation for this higher temperature construction is probable.

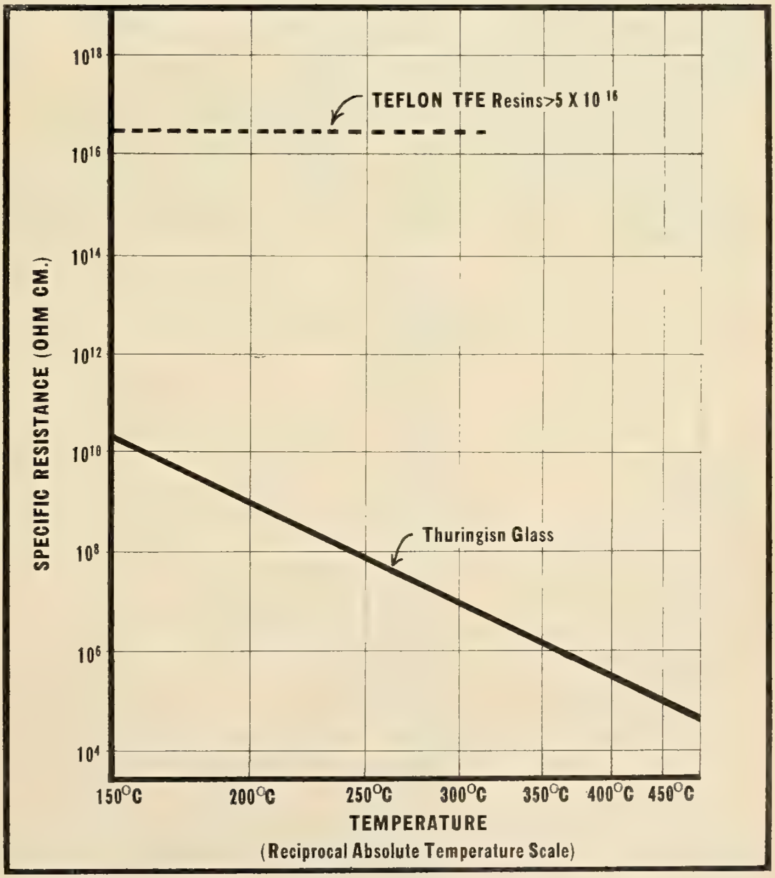
(4) Silicone rubber compounds and Teflon FEP resins significantly exhibit similar electrical and mechanical properties at elevated temperatures. The immersed dielectric test indicates a possible unsuitability of silicone rubber in applications where moisture exists.

(5) The superior combination of properties of Teflon—significantly high temperature resistance to cut-through, unsurpassed dielectric properties, and near-ideal chemical resistance—indicate its noteworthy advantages over the other materials tested.

(6) The use of Teflon-insulated wire is feasible for short time endurance at temperatures of 450°C and above. Such applications include missiles, launch site instrumentation, ground support cable, atmosphere re-entry vehicles, and many others in high-speed short-range aircraft launching facilities.



UNDER CONSTANT rise (10° C/min.), marked decrease in resistance starts near 300° C, continues to minimum at transition temperature. Values remain acceptable more than 20 min.



TFE-RESINS show specific resistance values considerably over those of glass.

French Show Missile Test Ship

by an M/R Correspondent

PARIS—The French Navy has publicly demonstrated its missile testing ship Ile d'Oléron. A former cargo vessel, the Ile d'Oléron was reconverted in 1957-1958 under sponsorship of the Centre d'Essais et de Recherches des Engins Spéciaux (CERES) of the French Navy. It has been used in testing since early 1959.

The ship is equipped with launching ramps for **Nord-Aviation** *CT-10/CT-20* target missiles. It has completed the testing of the subsonic experimental surface-to-air *Maruca* system which is used for the development of the *Masurca* surface-to-air weapon system. The *Masurca* will be on the French training ship/helicopter carrier Jeanne d'Arc, which will be commissioned in 1963, and on a missile launching cruiser to be commissioned in 1964. Construction was authorized in the 1960 budget.

The *Masurca* can be described as a French equivalent of the *Terrier*. The French say that it is less costly than its U.S. counterpart. The solid-propelled surface-to-air system should be operational in 1962. It weighs 1.5 tons, has a range of about 25 miles and Mach 2-2.5 performance. Testing will begin in October.

The Ile d'Oléron is also used to test the *Malafon* surface-to-under water anti-submarine weapon system which will equip the La Galissonnière, an escorter of the T-47 class. The La Galissonnière will become operational next summer. The French Navy has other ambitious plans: it is already beginning to suggest that the French solid-propelled IRBM, whose construction has been decided by the French Government, should be installed on atomic-powered submarines which would become part of the French strike-armoury to which General de Gaulle has recently assigned worldwide strike capabilities.

Atlantic Research Runs Materials Testing Service

ALEXANDRIA, VA.—A routine testing service for materials applicable to rockets and missiles has been established by the **Atlantic Research Corp.**

High-temperature tolerance tests and high-velocity gas flow resistance determinations utilizing both standard solid propellants and new, high-impulse aluminized propulsion systems are part of the facility.

ARC's Pine Ridge propellant plant is fully integrated for manufacturing and testing. It now occupies 600 acres, and facilities are being added at the rate of over a half million dollars annually.

The materials testing facilities are already being used by a number of producers. Similar work has been done for various government agencies under an approved security system.

Medaris Predicts Step-up In Activity at Redstone

HUNTSVILLE, ALA. — Even with ABMA's transfer to NASA, a net increase in investments and employment for Redstone Arsenal is being predicted for this year by Maj. Gen. J. B. Medaris, retiring Redstone Chief.

The Army, he said, will continue all of its current operations at Huntsville. And "while ABMA may lose a substantial number of its people to NASA, it will retain much of its competence in national procurement, military training and systems management. Some of the personnel losses must be replaced, in order to have a continuing research and development element."

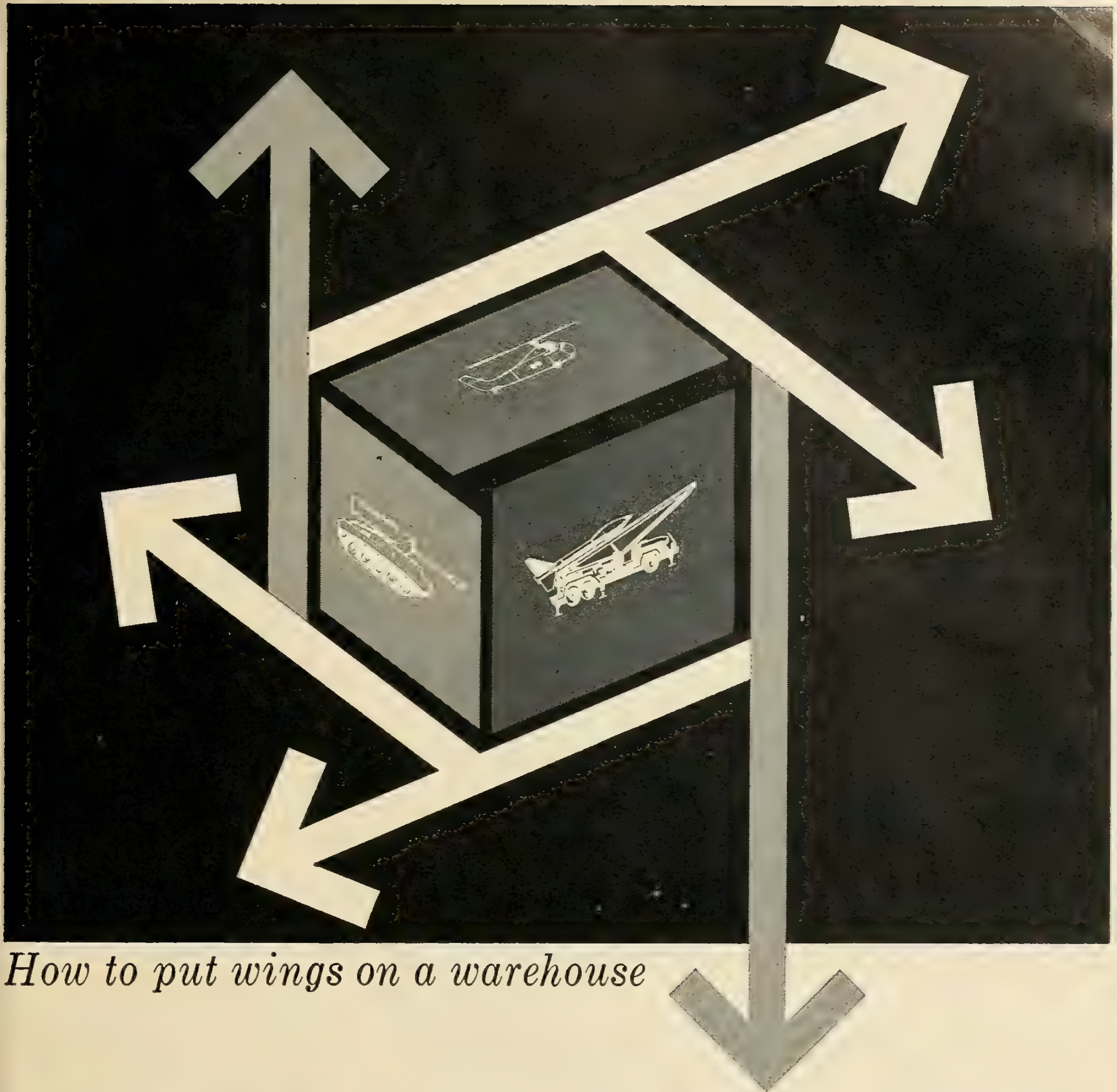
Also, he reported, certain additional projects will be transferred to ABMA, giving the Agency even broader responsibilities than it has had in the area of weapon systems.

Summarizing the Arsenal's growth since his arrival four years ago, Gen. Medaris pointed out that;

- The Arsenal budget has grown from $471,700,000 in 1956 to more than $2 billion today.
- Employment rose from 9048 to 21,936 in the four-year period with payroll figures jumping from $39,860,000 in 1956 to a 1959 figure of about $137 million.
- The government's investment in land and facilities, excluding equipment, has grown from $70,441,000 to $133,385,000 with another $27 million in construction now under way.

NBS Improves Retriever

WASHINGTON—An improved model of a high-speed document retrieval device has been developed by the National Bureau of Standards. The machine, developed for the Patent Office and Navy Bureau of Ships, examines binary coded patterns describing filed documents. Code and document images are on 35-mm microfilm which is read by the machine at the rate of 2400 pages per minute. Documents selected through code recognition are copied photographically without slowing the film.



How to put wings on a warehouse

Giving overseas air bases what amounts to local warehouse service on important parts is an Air Force objective. Its present system has slashed delivery schedules up to *20 times*...saved taxpayers several *billion* dollars over the past decade. To improve it further, Douglas has been selected to develop specifications for a comprehensive Material Handling Support System involving better communications, control, cargo handling and loading, packaging and air terminal design. Douglas is well qualified for this program by its more than 20 years in all phases of cargo transport. Air logistics is only one area of extensive Douglas operations in aircraft, missile and space fields in which outstanding openings exist for qualified scientists and engineers. Some are listed on the facing page.

Schuyler Kleinhans and Charles Glasgow, Chief Engineers of the Santa Monica and Long Beach Divisions, go over air transport needs relating to advanced cargo loading techniques with Donald W. Douglas, Jr., President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

The '50's—Rocketry Comes of Age

by Heather MacKinnon

WASHINGTON—While the next 10 years should be known as the Decade of Man-in-Space, 1950 through 1959 will be recorded in the pages of astronautical history as his preparatory years.

In this brief period, the world exploited the little known field of rocket technology which first showed its real military and astronautical significance with *V-2* experiments in the early 1940's.

But in the 1950's, families of military missiles were developed; many saw actual operational use toward the end of the period. Whereas at the beginning of the decade the emphasis was on manned aircraft, 1959 closed with the decided shift of emphasis to the missile as the major carrier vehicle for war.

At the mid-point of the decade, planning for orbiting the world's first artificial earth satellites began. And the Space Age dawned to an awakening world with the musical beep from *Sputnik I* on Oct. 4, 1957.

In the following pages, MISSILES AND ROCKETS recounts some of the major events of the 1950's. All could not possibly be listed because of space limitations, but it is hoped this chronology will be of benefit to readers.

1950

Jan. 24: Air Force established a separate Research and Development Command with Maj. Gen. Gordon P. Saville as deputy chief of staff.

Feb. 6: Navy's *Mighty Mouse*, air-to-air rocket, was successfully tested.

Feb. 18: The Air Force announced that it had fired a 12,00-lb. guided bomb and a 500 mi. self-propelled guided missile—no other data disclosed.

April 1: The missile team headed by Dr. Wernher von Braun, designer of the German *V-2*, was moved from White Sands to Redstone Arsenal, Huntsville, Ala.

April 11: General Electric's *"Hermes Project,"* a case-bonded solid-fuel engine which could go "further and faster" than the German *V-2* was revealed. **Thiokol** was also a contributor.

May 11: Army revealed *Loki*, a ground-launched rocket to seek out and destroy enemy aircraft up to 12 miles altitude.

May 11: A 106.4 mi. altitude record for U.S. single-stage rockets was set by a Navy *Viking*, fired from a ship to be used for cosmic ray research.

June 13: The Department of Defense assigned range responsibilities to the armed services: Army: White Sands, N.M., Proving Ground and nearby Holloman Air Force Base at Alamagordo; Navy: Point Mugu, Calif. Air Force: Long Range Proving Ground at Banana River, Fla. (now called Cape Canaveral).

July 24: A German *V-2* (14 tons) with a (700 lb.) *WAC Corporal* was fired at the Army Long-Range Proving Ground; the first stage climbed 10 mi., separated and was radar-exploded; the *Corporal* traveled 15 more miles.

1951

Jan.: Convair received *Atlas* contract, which had been cancelled in June, 1947.

June 21: The **Martin** TM-76 *Matador* made its first flight at Cape Canaveral, using for the first time the "down range" facilities in the Bahama Islands.

Aug. 8: The Navy *Viking* climbed a record 135 miles at White Sands, with a top speed of 4100 mph.

Sept. 3: The International Astronautical Federation was formed by scientists of 10 nations at the 2nd International Congress on Astronautics to coordinate responsibility on flights to the moon and planets. Predicted within the decade: a 50-ton earth satellite traveling 18,000 mph orbiting earth at an altitude of 300 miles.

Sept. 19: Navy revealed that it had been testing underwater missiles at TVA Hiwasse Dam for as long as nine years.

Oct. 4: A $25-million Navy contract went to the **Sperry Corp.** for a guided missile plant near Bristol, Tenn.

Nov. 26: A 10-year agreement was made by the U.S. and Dominican governments for track and control bases to be built in the Dominican Republic.

1952

April 1: Navy announced production of three new guided missile types for service next year: the *Terrier* (**Consolidated Vultee**); the *Regulus* (**Chance Vought**); and the *Sparrow I* (**Douglas**).

May 27: Ryan Aeronautical Co. receives a contract from **Aerojet Engineering Corp.** for production of rocket engine components developed by Aerojet.

June 27: Northrop began six-month training course in guided missiles.

June 30: President Truman signed a bill authorizing $19 million for NACA laboratories involving further construction and new equipment.

July 15: BuAer chief announced that the first ship-to-surface guided missile would be placed in service this year.

Dec. 16: The U.S. Navy again sent a *Viking* up 135 miles at White Sands, and revealed that it had launched rockets from balloons in the geomagnetic North Pole area for cosmic ray research.

1953

Jan. 23: Guided Missile Committee was created by Aircraft Industries Association to handle collective problems in research, design, construction and testing of missiles.

Feb. 9: Grand Central Aircraft Co. established a Rocket Division at Pacoima, Calif., to develop and produce solid-propellant rocket motors and complete missiles, including one under contract with the Army Ordnance Corps.

March 30: The first details on the *Regulus* missile were disclosed by the Navy. In production at **Chance Vought**, the 30-ft. missile is to be capable of supersonic speed.

Aug. 4: Evidence that Russia was rebuilding former German rocket bases on the Baltic was presented at the International Astronautical Congress.

Aug. 7: Dr. Wernher von Braun assured the IAF that U.S.-developed propellants were capable of shooting a rocket into satellite orbit for a space station.

Sept. 9: Secretary of Defense Charles E. Wilson appointed Trevor Gardner to head a committee to eliminate interservice competition in development of guided missiles.

1954

Jan. 11: The existence of the *Rascal* guided missile was officially confirmed by **Bell Aircraft Corp.**, but no details were released.

Jan. 15: Air Force announced that two *Matador* squadrons would be sent to West Germany for NATO defense.

May 24: The Navy *Viking* set another record with a 158-mi. climb, top speed 4300 mph at White Sands, N.M.

May 27: Pres. Eisenhower signed $5-million expansion bill for NACA to be used in research for ICBM fuel and high-speed seaplane fighters.

Sept. 29: Chrysler received its first missile contract from the Army—$22 million to build the *Redstone*.

Oct. 9: $500 million was added to the current year's budget for the guided missile program. (In FY 1950 through '54, $700 million was spent.)

Dec. 1: The Navy received the Boston and Canberra, converted to become the world's first true guided-missile ships, using *Sparrow I*, *Terrier* and *Regulus* which were in the hands of the fleet at this time.

Dec. 27: Lt. Col. John P. Stapp rode a rocket sled at Holloman Air Force Base at 632 mph and stopped 1½ seconds after attaining the land speed record.

1955

Jan. 17: Hughes Aircraft made first deliveries of new E-9 fire control system to enable **Northrop** F89D's to use guided missiles.

Jan. 20: Navy let $16-million contract to **Chance Vought Aircraft** for *Regulus* guided missiles.

Mar. 6: Air Force Chief of Staff Twining reported that ICBM's were receiving priority in the AF program because of known Soviet progress and possible bases in China. **North American's** *Navaho*, **Northrop's** *Snark* and **Convair's** *Atlas* programs accelerated.

Mar. 14: DOD officials announced that guided missile spending would reach $518 million in FY '55 and $674 million in '56.

Mar. 18: USAF-**North American Aviation Corp.** contract for long-range *SM-64* missile (formerly designated *B-64*) revealed.

Mar. 23: At IRE convention, speakers disclosed work on instrumentation for de-

vices to be launched by the Rockaire technique, which called for the launching of missiles from high-altitude aircraft as a probable first step to establishing a space radio transmitter.

Mar. 28: **Bell Aircraft Corp.** revealed that it was supplying the rocket engines which would power *Nike*.

Apr. 20: Details of *Aerobee-Hi*, a new high-altitude research rocket, were revealed.

May 31: NATO officials investigated use of *SS-10*, a French-produced guided missile for air-to-air or air-to-ground missions.

July 1: A six-month training course on the *Corporal 2* guided missile was inaugurated for a small group of British Army personnel to become instructors for British Army units using American missiles.

July 20: The first pre-production order by the Canadian Government was placed for an air-to-air missile.

July 31: The USSR disclosed plans for a satellite, and hired 120 German scientists.

Aug. 1: The White House announced that the U.S. also planned to launch a small unmanned satellite (to be about the size of a basketball) sometime after July, 1957.

Aug. 2: The Navy announced that it was receiving *KDU-1*, a target drone version of the *Regulus* missile from **Chance Vought.**

Oct. 7: The prime contract for a major part of earth satellite program jointly sponsored by the Army-Navy-Air Force was awarded to the **Glenn L. Martin Co. General Electric** was to provide the rocket engine.

Nov. 2: The **Fairchild** *Petrel* was entering operational stage, according to Adm. Arleigh A. Burke, Chief of Naval Operations.

Dec. 13: **Aerojet-General** was announced as the subcontractor to build the second-stage rocket propulsion system for Project *Vanguard* by Navy and **Glenn L. Martin Co.**

Dec. 20: Wilson reported the FY '57 would have a record $1 billion for development and production of guided missiles, over the $750 million in FY '56. He also predicted an ICBM with a nuclear warhead within the next 5 years.

1956

Jan. 6: Pres. Eisenhower in his State of the Union message noted the increasing importance of long-range missiles and nuclear-powered aircraft. $1.275 billion was scheduled for FY '57 production of guided missiles with an additional $1.43 billion for military research and development.

Jan. 10: Gen. Taylor, Army Chief of Staff, reported that the Army was "putting everything we've got into IRBM's." The Navy also disclosed that the IRBM was receiving priority, while the Air Force, concentrating on the ICBM, maintained that "know-how" for the IRBM would be achieved simultaneously.

Jan. 13: An AF *Snark* was flown 2000 miles from Cape Canaveral, achieving a 30,000-ft. altitude.

Jan. 13: Army Secretary Brucker disclosed that an electronic "missile master" to detect enemy planes and missiles and coordinate all *Nike* batteries in an entire target area was now in operation. Taylor added that the *Nike* "could destroy anything."

Jan. 26: The Air Force awarded **Aerojet-General Corp.** a $9-million contract for facilities for the pilot production and production testing of liquid rocket engines.

Feb. 9: Air Force Secretary Donald A. Quarles denied that missiles would be decisive for at least 5 years, and that the ICBM was the "ultimate weapon"; he hinted at an interceptor missile.

Feb. 16: **Ryan's** *Firebee* remote-controlled jet drone was pronounced operational.

Feb. 23: A new office of Deputy Director-Ballistic Missiles was created in the Directorate of Procurement and Production by the Air Material Command.

Mar. 20: **Martin Co.**'s scientific breakthrough allowed *Vanguard* to be the first liquid-fuel rocket design to be controlled without fins, according to a Navy announcement.

Mar. 27: Defense Secretary Wilson appointed **Esso** President Eger Murphree his "missile czar," and revealed that **Convair's** *Atlas*, **Martin-Denver's** *Titan*, and **Douglas Aircraft's** *Thor* were all in the development stage.

Apr. 2: AF fired *Snark* a distance between 1500 to 5000 mi. from Patrick AFB, Fla.

Apr. 3: Navy's program to procure guided missiles would jump from $126 million in FY '55, $238 million in FY '56, $353 million in FY '57, according to Navy Sec. Thomas.

Apr. 4: *Petrel* was fleet operational, according to Navy officials.

Apr. 30: A House subcommittee heard that guided missiles, which accounted for 20.3% of the AF's FY '57 budget might climb to 35% by 1959.

May 3: Plans were disclosed by the AF and **Convair** for a $41-million guided missile facility at Sorento, Calif., ostensibly for work on *Atlas*.

May 18: The development of a new high-altitude research rocket known as the *Asp*, for Navy's BuShips was announced by **Horning-Cooper, Inc.**

June 20: Announcement that the Navy had a solid-propellant rocket underway was confirmed by Missile Chief Murphree.

June 22: The Japan Center Meteorological Observatory announced that the USSR had exploded a missile-borne H-weapon at a 22 mi. altitude.

June 23: Adm. Burke warned of Russian missile launching subs as a real threat.

June 27: Senate Armed Services committee rejected an AF request to set up four *Talos*-equipped anti-aircraft bases, but approved Army plans for expansion of the *Nike* program.

July 24: Navy Guided Missile Director disclosed that by 1961, 89 ships would be equipped with surface-to-air missiles.

Aug. 8: The largest U.S. test stand for rocket motors was completed at Redstone Arsenal, slated for *Jupiter* IRBM.

Sept. 18: ARDC disclosed it had a research rocket which could accelerate to 5000 mph in about two seconds.

Oct. 5: **The Martin Co.** announced that *Lacrosse* was in production for the Army.

Oct. 11: NACA disclosed that four-stage research rockets had hit speeds of 6864 or Mach 10.4.

Oct. 16: Navy planes received *Sidewinder*.

Nov. 2: DOD officials announced that the **Boston**, first guided missile cruiser, would be dispatched to the Mediterranean to join the Sixth Fleet.

Nov. 26: Secretary of Defense Wilson ruled on U.S. service jurisdiction in the missile program. Army restricted to development and operation of missiles having up to 200 mi. range, missiles for "point" defense against air raids and for tactical support of ground forces. Existing systems: *Nike I*, *Nike B*, and *Talos*. Air Force—Sole responsibility for the development and operation of surface-to-air missiles for "area" defense, ICBM's and IRBM's—existing IRBM, the *Bomarc*. Navy—Ship-based missiles, "suited to accomplishment of its assigned functions." Marine Corps—May adapt others for its use.

Dec. 3: The first known guided missile-launching destroyer, the Gyatt, was commissioned at the Boston Naval Shipyard. Its principal weapon, the *Terrier*.

Dec. 4: The AFL-CIO formed an "Aircraft and Guided Missile Industry Joint Committee," in Washington, D.C.

Dec. 8: The first test rocket for a U.S. satellite, a three-stage *Viking* considered a 45' scale model of 72' *Vanguard*, attained an altitude of 125 miles and a speed of 4000 mph. The rocket carried a "minitrack" radio transmitter which was ejected at 50 mi. and tracked.

1957

Jan. 9: Navy awarded $27 million contract to **Bendix** for *Talos* anti-aircraft guided missile.

Feb. 7: **Ryan's** *Firebee* drone set new altitude and endurance records by soaring 53,000 mi. and remaining on remote control for 1 hr., 44½ min.

Mar. 26: First *Lacrosse* came off production line.

Apr. 23: Details of **North American's X-15** were revealed for the first time.

May 16: Production contract for *Bomarc IM-99* interceptor missile was signed between AF and **Boeing Airplane Co.**

May 28: Navy and **Martin Co.** announced new air-to-surface missile, the *Bullpup*, was undergoing Navy evaluation.

June 5: Army announced that a *Jupiter* mid-range missile was fired 1500 miles, limit of its designed range, and to an altitude of 250-300 miles.

June 12: **Raytheon Mfg. Co.** was named prime contractor of entire *Hawk* weapon system by Army.

July 1: International Geophysical Year began.

July 2: Air Force ordered into mass production the country's first military missile of intercontinental range, the *Snark*.

July 11: *Navaho* missile program cancelled by Air Force.

Aug. 26: Soviets announced firing of *TR-3*, a huge ICBM, and claimed that their *TR-2* (IRBM), was in production and undergoing advanced testing.

Oct. 4: The Soviet Union launched *Sputnik I*.

Oct. 23: *Vanguard* flew to a 109 mi. alt., at 4250 mph.

Oct. 23: A four-stage, 1900-lb. research rocket was launched in a rarified atmosphere from a balloon-borne launcher 100,000 ft. over Central Pacific.

Oct. 24: *Thor* fired at Cape Canaveral.

Nov. 1: *GAM 63, Rascal* became operational with SAC at Pinecastle AFB, Fla.

Nov. 3: *Sputnik II*, carrying the dog Laika, launched by the Soviet Union.

Nov. 4: Navy awarded a $62-million contract to **Lockheed Aircraft Corp.** for developing *Polaris* IRBM.

Nov. 7: Pres. Eisenhower announced that there are 38 types of US missiles in operation or development, with *Falcon, Sidewinder, Sparrow I, Rascal, Nike-Ajax, Terrier, Corporal, Honest John, Matador* and *Regulus I* operational.

Dec. 6: *Viking* rocket failed on pad.

Dec. 17: *Atlas* made first flight at Canaveral, flying 500 miles.

1958

Jan. 4: *Sputnik I* disintegrated.

Jan. 31: The first American satellite, *Explorer I*, launched.

Feb. 5: Trial firing of *Vanguard* test satellite failed at Canaveral.

Feb. 7: ARPA created.

Mar. 5: *Explorer II* launching fails.

Mar. 17: *Vanguard I* satellite launched, life expectancy of perhaps 200 years.

Mar. 26. *Explorer III,* U.S. satellite, went into orbit around earth.

April 13: *Sputnik II* plunged to earth.

April 23: *Thor-Able* containing a mouse in its nose cone was launched from Cape Canaveral in a re-entry test, but fell short of its goal and was not recovered.

April 28: A *Vanguard* fired by the Navy at Cape Canaveral failed to reach required speed to orbit and burned up in re-entry.

May 1: Details on the Van Allen belt were disclosed by Dr. James Van Allen.

May 15: *Sputnik III,* Soviet satellite, started orbiting earth.

May 18: A *Jupiter* missile was fired 1600 miles and the nose cone was recovered.

May 27: *Vanguard II* made a normal takeoff, but incorrect angle carried it only 2000 miles to burn up in re-entry.

June: *Nike-Hercules* became operational.

June 26: Another *Vanguard* failed.

July 9: A second *Thor-Able* was launched, traveling 6000 miles.

July 23: A *Thor-Able* made another successful 6000-mile flight, although the nose cone was lost.

July 26: *Explorer IV,* fourth U.S. satellite, successfully launched.

Aug. 1: A nuclear weapon believed capable of prematurely triggering the warhead of an oncoming ICBM was exploded by the U.S.

Aug. 6: Rocketdyne division of North American announced an Air Force contract for a 1,000,000-lb.-thrust engine.

Aug. 7: A *Bomarc* defense interceptor was launched by remote control 1500 mi. away, but failed to find its target.

Aug. 12: *Talos* "bagged its prey"—the first missile to hit Lockheed's specially developed *XQ-5,* a supersonic ramjet drone.

Aug. 17: First AF lunar probe ripped apart by an explosion 77 seconds after launch.

Aug. 24: *Explorer V* missed orbit.

Aug. 27: The Soviet Union sent two dogs to an altitude of 281 miles and safely returned them to earth.

Sept. 7: Great Britain's *Black Knight* launched to an altitude of over 300 miles.

Sept. 24: The first meeting of the newly created NASA held, with Dr. T. Keith Glennan as administrator.

Sept. 17: *Regulus II* fired for first time from a submarine at Navy's Point Mugu.

Sept. 17: *Vanguard* fell back on pad after firing, was saved.

Sept. 26: *Vanguard* fired, did not attain orbit and burned on re-entry.

Oct. 11: *Pioneer I,* first successful space probe, launched from Cape Canaveral.

Oct. 15: Rocket ship *X-15* unveiled for first time.

Oct. 22: *Beacon,* intended U.S. satellite, failed when last two stages did not fire.

Nov. 6: Army completed *Redstone* testing with a perfect 250-mile shot.

Nov. 8: *Pioneer II* climbed 1000 feet, then fell.

Nov. 28: *Atlas* made its first successful test flight in a 6325-mile trip, landed within 30 miles of its target.

Dec. 6: *Pioneer III* launched, presumably disintegrated after reaching speed of 24,000 mph.

Dec. 13: Space monkey Gordo made trip in *Jupiter* with no untoward effects, but float mechanism failed and nose cone was not recovered.

Dec. 16: Two *Thor* shots successful.

Dec. 17: Project *Mercury* got its name, and Rocketdyne was awarded contract for engine with up to 1.5-million pounds thrust.

Dec. 18: An *Atlas* missile launched and put into orbit under code name of Project *Score.*

Dec. 18: Navy cancelled *Regulus I.*

Dec. 19: President Eisenhower's Christmas message beamed from Project *Score*—the first voice in space?

Dec. 20: White Sands Long-Range Proving Grounds announced missile range firing record—2000 "hot" firings in one year.

1959

Jan. 2: Defense officials indicated FY '60 budget would begin major integration of long-range missiles into weapons arsenal and replace manned aircraft on a large-scale by '60, '61.

Jan. 2: USSR launched *Lunik I,* into a solar orbit.

Jan. 4: Vandenberg Air Force Base and the Pacific Missile Range were officially ready for firings.

Jan. 9: Administration repeatedly rejected USAF proposal to expand ICBM squadrons from 13 to 20 despite warnings of growing gap with USSR.

Jan. 17: *Atlas* flew 200 miles.

Jan. 19: The U.S. Navy announced that it had developed a rocket engine and control system deemed flexible enough for manned flights and moon landings, operable by single hand lever. The engine would use 2 fuels igniting on contact, fed from pressurized containers that eliminate complex pumping systems.

Jan. 20: The first operational-type *Polaris* firing was successful on an 800 mi. test at Cape Canaveral.

Jan. 21: *Atlas-Score,* 8700-lb. U.S. satellite, destroyed in reentry.

Jan. 22: The first *Jupiter* tactical model was fired from Canaveral 1700 miles and hit its target.

Jan. 23: *Thor-Able* fails.

Jan. 28: 110 candidates were selected in the first screening for Project *Mercury.*

Feb. 4: The U.S. was believed able to monitor ICBM countdowns, launchings and above atmosphere flights by radio-radar devices based around the USSR.

Feb. 17: *Vanguard II* launched by the U.S., to last more than 10 years.

Feb. 20: NASA awarded $105 million in contracts for '59 projects (15 satellites to be launched.)

Feb. 26: First *Titan* was successfully fired a limited range at Cape Canaveral.

Feb. 28: *Discoverer I,* 1450-lb. U.S. satellite, launched from Vandenberg.

March 1: "Poor man's rocket," *Scout,* was announced by NASA and AF.

March 3: *Pioneer IV,* U.S. 13.4-lb. lunar space vehicle, was launched, (after four failures), missed its intended trajectory by a fraction, and shot past moon to orbit sun.

March 5: *Discoverer I* presumed burned up on re-entry into atmosphere at an unknown point.

April 8: U.S. recovered first *Thor-Able* nose cone after 5000-mi. flight from Cape.

April 13: *Discoverer II* launched by U.S., a 1610-lb. satellite, from Pacific Missile Range into polar orbit.

April 13: *Vanguard* launching failed when payload and 3rd stage fell into ocean after only 500 sec. flight time.

April 26: *Discoverer II* fell, capsule was not recovered after timer malfunctioned ejecting capsule in vicinity of Spitzbergen Islands instead of Hawaii, the intended impact area.

May 15: Lt. Gen. Bernard A. Schriever, Commander of ARDC, unveiled first re-entry vehicle ever to be recovered after a full intercontinental range flight, built by GE of Avco's Avcoite.

June 3: *Discoverer III,* U.S. satellite, launched; second stage, which was to go into orbit, fired—but officials doubted its success.

June 22: *Vanguard* satellite fired, but a faulty second-stage pressure valve caused failure and rocket plunged into Atlantic Ocean some 300 miles northeast of Atlantic Missile Range.

June 25: *Discoverer IV* failed due to insufficient velocity.

July 16: *Explorer,* launched by *Juno II,* was exploded by the range safety officer when it tilted sharply due to failure of power supply to guidance system.

July 18: Navy's *Corvus* fired successfully in first test.

July 21: *Atlas* nose cone was successfully recovered.

Aug. 7: *Explorer VI,* U.S. "paddlewheel" satellite was launched by a *Thor-Able III.*

Aug. 13: *Discoverer V,* U.S. Satellite and nose cone re-entry capsule, launched from the Pacific Missile Range goes into orbit, although capsule was not recovered because of a malfunction.

Aug. 14: *Beacon* attempt at launching U.S. satellite failed because of premature fuel depletion in booster and malfunction in attitude control system for upper stages.

Aug. 17: A sodium flare was lighted 150 mi. above earth from a *Nike-Asp* research rocket at Wallops Island to study direction and velocity of wind and rate of diffusion of matter in upper atmosphere.

Aug. 19: *Discoverer VI* satellite launched.

Aug. 27: *Polaris* successfully launched for first time.

Sept. 9: *Big Joe,* test version of astronauts, capsule, rocketed 1500 miles into Caribbean and was pulled out in "extremely good condition."

Sept. 12: *Lunik II,* Russia's 858.4-lb. package, impacted on the moon.

Sept. 16: A *Jupiter* launched from Cape Canaveral, destroyed by a range officer after fishtailing, carried 14 pregnant mice, 2 frogs and other biological specimens.

Sept. 16: A full-sized *Minuteman* ICBM model was fired from an underground silo.

Sept. 16: *Discoverer V* fell.

Sept. 17: *Transit I,* U.S. satellite attempt failed to achieve orbit.

Sept. 18: *Vanguard III,* U.S. satellite launched for an estimated 30-40 year life. Complete *Vanguard* program.

Oct. 4: *Lunik III,* Russia's translunar earth satellite began photographing trip around moon.

Oct. 13: *Explorer VII,* U.S. *Juno-II*-launched satellite went into orbit with a life expectancy of 20 years.

Oct. 14: "Paddlewheel satellite," *Explorer VI* ceased transmitting.

Oct. 14: First test flight of *Nike-Zeus* anti-missile bird was made.

Oct. 20: *Discoverer VI* fell.

Oct. 21: President Eisenhower decided to bring the Army Ballistic Missile Division, Huntsville, Ala., with Von Braun and his team under NASA. Decision subject to Congressional action.

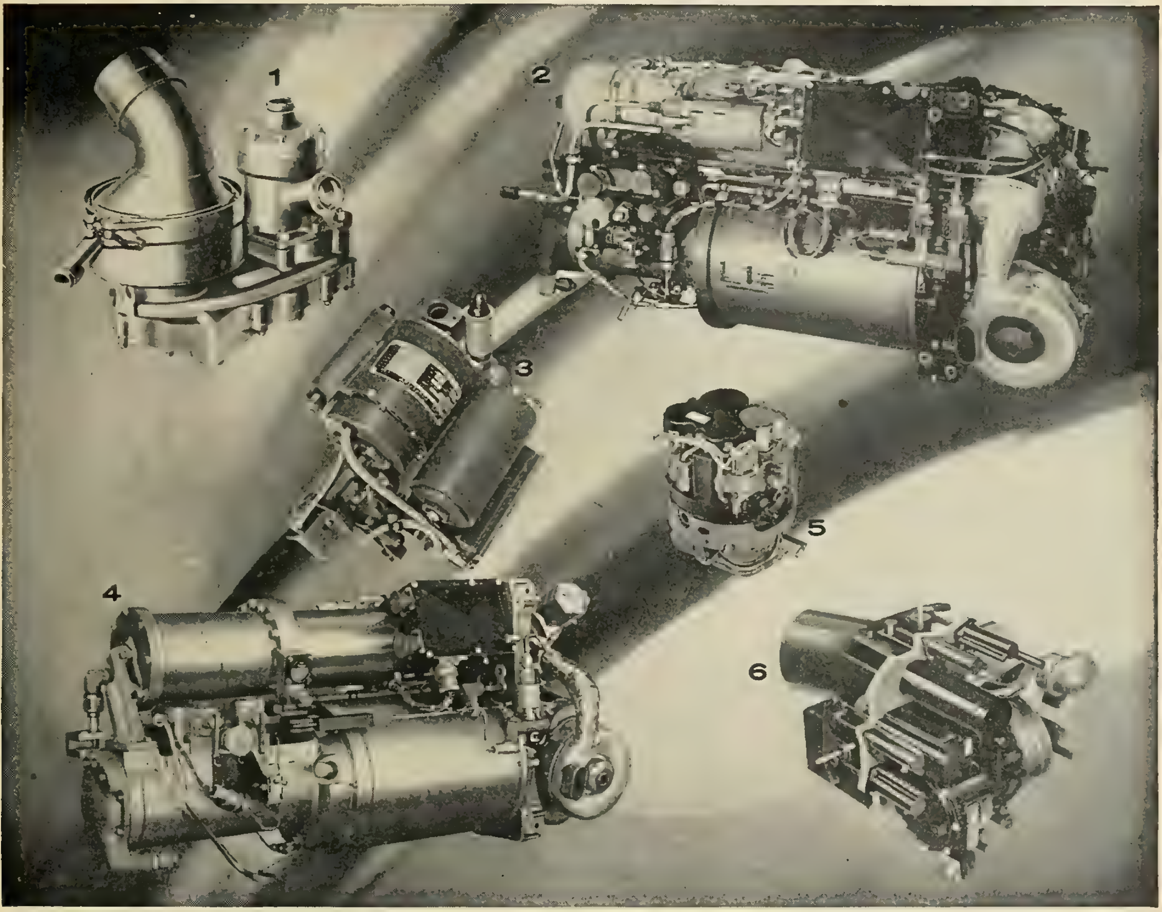
Nov. 7: *Discoverer VII* satellite went into orbit, but re-entry capsule was not released because of a failure on the electrical system. Expected life—2 weeks.

Nov. 11: Air Force announced decision to go ahead with *Dyna-Soar* program.

Nov. 26: *Atlas-Able* test vehicle explodes, dashing hopes for another U.S.-satellite and recapture of prestige.

Dec. 13: NASA cancels the $65-million *Vega* space vehicle program.

DELIVERED—thousands of missile APUs



1. *Solid propellant—hydraulic output* **2.** *Liquid propellant—hydraulic and electric output* **3.** *Solid propellant—electric and mechanical drive output* **4.** *Liquid propellant—hydraulic and electric output* **5.** *Solid propellant—hydraulic and electric output* **6.** *Solid propellant—hydraulic, electric and steering outputs*

AiResearch has designed, developed, manufactured and delivered thousands of missile accessory power units. Extremely reliable and lightweight, these various solid and liquid monopropellant APUs are completely self-sustaining within the missile system. Designed to minimum space and weight requirements, they are built to withstand high G loading and severe temperature extremes.

The several units pictured above provide hydraulic, electrical and/or steering surface control depending on the customer's requirement. Delivered horsepower ranges from 1.2 to 35 h.p. over hot gas operating durations from 30 seconds to 20 minutes. Electrical regulation is maintained as closely as ±½%. A significant advance in missile APUs is unit #6 pictured above. This package represents the first integrated hydraulic and electrical power unit providing a steering surface actuation system.

These tailored systems utilize the extensive hardware experience and complete laboratory, test and production facilities of AiResearch needed for quick and efficient quantity production of complex APU systems. AiResearch is the world's largest and most experienced manufacturer of lightweight turbomachinery—the key component of its APU systems. Your inquiries are invited.

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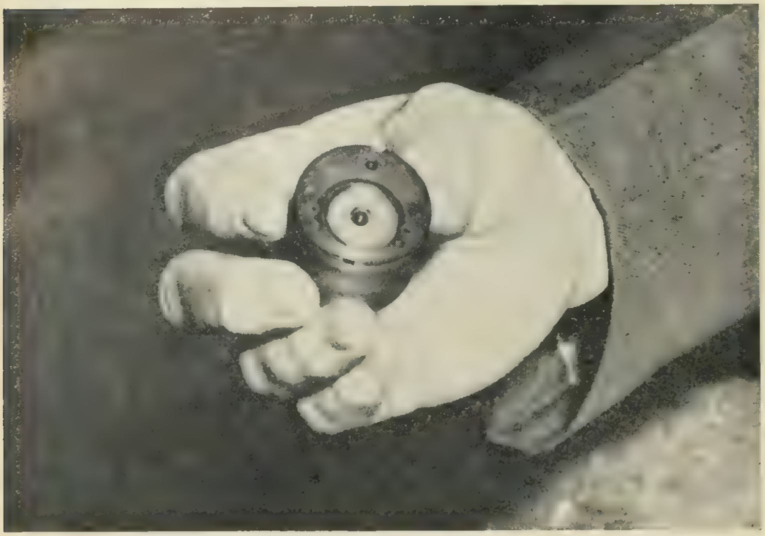


Camera Measures Missile Accuracy

WOOMERA, AUSTRALIA—A miniature one-shot camera, less than two inches in diameter, is being used here to measure missile accuracy. Mounted in the missile's nose section, the camera was developed to measure the attitude of a missile relative to its target and vector miss-distance. It can also photograph the ground or horizon to indicate missile attitude relative to the earth.

Designed and developed by the Weapons Research Establishment here and manufactured by **Fairey Aviation,** the WRECISS (WRE Camera Interception Single Shot) has a field of view of 186 degrees. Two of the units mounted back-to-back give full 360-degree coverage.

The camera can measure miss-distance to an accuracy of 5% and missile-to-target attitude to approximately ±1 degree. Relative to ground axes, attitude can be measured to ±1 degree in pitch and roll and, by reference to the sun, to ±3 degrees in heading.

The WRECISS is triggered by a 45-150 volt electrical impulse from either a proximity fuze or from an error-signal voltage from the guidance system as the missile passes its target. Exposure time is 0.3 msec. About 30% of the cameras can be reused after recovery after replacement of the expendable firing lever.

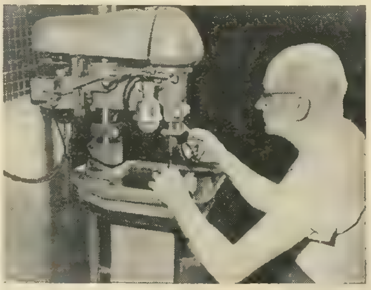
Circle No. 225 on Subscriber Service Card.

Drill Press Has Speeds to 12,000 rpm

A new 14-inch Hi-Speed Drill Press, with speeds up to 12,000 rpm, has been introduced by **Rockwell Manufacturing Co.'s** Walker-Turner Division.

Engineer for high speed, small hole drilling where precision and sensitivity are needed, the new press is ideal for manufacturers of specialty parts, electronic devices and similar equipment. It is recommended for all drillable materials, particularly precious metals, phenolics and non-ferrous metals such as aluminum, brass and copper.

Drill breakage and work spoilage is reduced by a counterbalanced quill that



eliminates quill drop at break-through on through holes.

Vibration-free, accurate operation is assured by preloaded, lubricated-for-life ball bearings with a 14-spline "floating" sleeve drive. This sleeve drive includes a taper-hole mounted spindle pulley, lapped quill, etc.

The press is available in single spindle models or with any number of spindles in multiple spindle set-ups. Both single spindle or multiple spindle models come with production table, No. 72-¼-inch key chuck and choice of single, three phase or D. C. 1/3-horsepower motor.

Circle No. 226 on Subscriber Service Card.

Potentiometer Available With Special Shaft Flanges

Gear coupling to the highly accurate Series 2 "Vernistat" precision a. c. potentiometer may be obtained with special shaft flange versions of the components introduced by the Vernistat Division of the **Perkin-Elmer Corp.**

The main feature of these special

units is a precision shaft coupling assembled with the Vernistat to obtain maximum mechanical accuracy in coupling the component to other elements in a system. Three mounting holes and an accurate machined slot locate a gear on the Vernistat shaft.

Characteristics of the Series 2 Vernistats include linearities from ±0.05%, output impedances from 45 to 470 ohms, input impedances from 65,000 to 200,000 ohms, and extremely low phase shift. The ten-turn Vernistat operates at 130 volts at a nominal 400-cycle input.

The a. c. potentiometer is a combination of a tapped autotransformer

and a precision interpolating resistance element. The component finds widespread use in precision military servos for inertial guidance, analog computers, and simulator systems.

In addition to standard linear versions, the Vernistat design enables the components to be constructed to generate nonlinear functions with extremely high conformity (e.g. sine 0 - 360° can be provided with a conformity deviation not exceeding ±0.25%).

Construction features include class 5 ball bearings, centerless ground shaft, and accurately machined size 18 aluminum housing.

Circle No. 227 on Subscriber Service Card.

Shock Testing Machine For Small Components

Barry Controls Inc., announces development of the 16750 Varipulse Shock Machine, specifically designed for production and laboratory testing of small electronic, electromechanical and mechanical components.

Fourth of a series of shock testing

machines, Type 16750 accommodates test specimens weighing up to twenty pounds and occupying an eight-inch cube. It provides accurate and repeatable half-sine, saw-tooth, and square waves.

The same pulse is reproducible in test after test and from one machine to another, eliminating the confusing variety of test results obtained from older type sand-drop equipment.

Like others of the Varipulse line, the 16750 utilizes the gravity free-fall principle for simplicity, economy of operation, and minimum maintenance. A remote push-button control and a disconnect interlock provide safety features for the protection of the operator.

The 16750 Varipulse requires only a 110-volt power source—no gas or hydraulics involved. No special foundation is needed. The machine may be operated manually or automatically for any of the specified shock pulses. When the resilient pads for half-sine pulses are used, the elevator table is mechanically caught at the peak of rebound to assure a single, undistorted pulse.

Circle No. 228 on Subscriber Service Card.

Miniature Tape Recorder Has Space Applications

A new model of miniature tape recorder designed for reliable operation over wide temperature range under extreme shock and vibration conditions has been announced here by engineers of the **Leach Corp.'s Special Products Division.**

The recorder is already in use by the U.S. Air Force Geophysics Research Center at Bedford, Mass., on space probe projects, and by **Goodyear Aircraft Co.** on tests of the *Subroc* missile.

Developed especially for use in space vehicles where critical conditions prevail, the model known as the MTR-1200 can also be put to various military, commercial and industrial uses, company engineers said.

The MTR-1200 is completely self-contained and requires only external power for operation. It features all metal surface recording heads, modular construction and ease of operation. The unit can be driven in either direction and contains an end-of-tape sensor.

Tape length choice offers either 650 feet of 1 mil Mylar tape or over 800 feet of ¾ mil pre-tensioned tape of either ½" or 1" width.

Circle No. 229 on Subscriber Service Card.

Low-Cost Centrifuge Has One Percent Accuracy

A new rotary centrifuge featuring moderate accuracy and very low cost is announced by **The Gyrex Corporation,** Santa Monica, Calif. Designed to provide production departments with a small instrument capable of fast testing

at pre-set accuracies, the Gyrex G-RATER operated up to 100 g of acceleration force in a number of standard speed ranges.

Basic accuracy of the instrument is better than 1% in terms of RPM. Two matched objects larger than 3" cube and 5 pounds weight can be tested in three axes on the standard booms. First models of the G-Rater have useful book radii of 12 inches. Eight slip rings are standard.

Start and stop times of the machine between zero and full speed at full load can be varied down to 2 seconds, approximately.

Circle No. 230 on Subscriber Service Card.

Electronic Gauge Measures All Coating Thicknesses

Coatings of any type and thickness can now be measured quickly and accurately with an electric micro-guage and comparator called the Elcotector, now available for the first time in the U.S., from the Supply Division of **Ferro Corp.**

In addition to measuring metallic

and non-metallic coatings on any dissimilar bases, the unit will also compare the hardness and grades of metals and other materials.

The unit operates on the eddy-current principle by making use of the fact that the electrical characteristics of a coil are influenced in proportion to the conductivity of the materials being measured. Housed in an aluminum desk-type cabinet 12"x8"x8", the instrument may be operated at 100/115, 220/230 or 240/250 volts A.C., 50/60 cycles.

The Elcotector is manufactured in England by the **East Lancashire Chemical Co., Ltd.,** who also manufacture a small pocket size thickness gauge called the Elcometer which measures coating thickness by the magnetic principle.

Circle No. 231 on Subscriber Service Card.

Absolute Pressure Switches Operate at High Temps

A line of absolute pressure switches capable of continuous duty at temperatures from −65 to 1000°F has been

introduced by **Consolidated Controls Corporation,** a subsidiary of **Consolidated Diesel Electric Corporation.**

The switches are intended for use in locations where high temperatures do not permit the use of standard pressure switches as in hot spots near aircraft and missile engines or where air friction at high speeds raises temperatures abnormally.

They are used to provide electrical signals at predetermined pressure levels in such media as air, oxygen, steam, and hydraulic and other aircraft fluids.

Currently available are units for operation at any pressure in the range of 20 to 200 pounds per square inch absolute, with proof pressures to 375 psi absolute. The accuracy of the operating point is within 10% for most models over the entire temperature range. The differential between make and break of the electrical contacts on increasing and decreasing pressure is 2 psi maximum.

Electrical contacts are rated for 1 amp resistive at 28 volts dc. They are furnished in a single-pole, single-throw configuration to either make or break the circuit at the desired pressure.

Units are built to withstand the vibration requirements of MIL-E-005275B, Procedure I, extended 1,000 cycles per second, 10 g. Shocks of 40 g have no effect on the switches.

The pressure inlet port is in accordance with MS33656-3 or to meet special requirements. Electrical connection is by means of sealed ceramic terminals.

Units are mounted by a strap around the body or by a suitable bulkhead type port.

Ability to withstand high temperatures is achieved through all-welded construction of Inconel and Inconel-X.

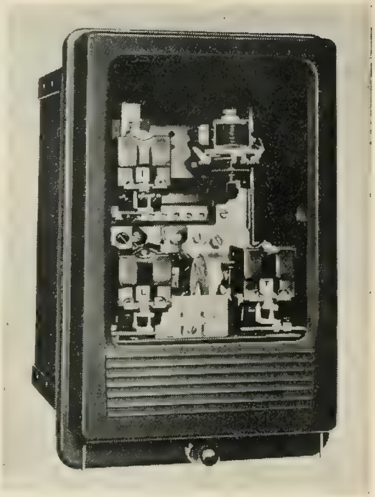
Circle No. 232 on Subscriber Service Card.

Relay Gives Motor Protection From Overloads

A new relay (type COM-5) for complete motor protection from very light to heavy overloads is now available from the **Westinghouse Electric Corp.** The relay provides protection by combining several elements to more closely match the motor heating curve.

From minimum pickup to 175 percent of tap value setting, an alarm is sounded and an operator is allowed five to ten minutes to remove the trouble. With medium overloads, the COM-5 gives normal time delay tripping protection. The relay provides for instantaneous tripping on heavy fault current.

In the past, a number of indepen-



dent relay packages were required for complete motor protection. Now, with the new COM-5 relay, a more convenient and versatile package is provided.

Circle No. 233 on Subscriber Service Card.

New Literature

LAMINATED PLASTIC. 20-page catalog available from the **Cadillac Plastic & Chemical Co.** describes its lined laminated plastic sheets, rods and tubes lists available grades and properties, illustrates typical applications and gives fabricating and finishing information. Special features of each grade are noted. More than 50 laminate grades are described. Included are phenolics, melamines, epoxies and silicones with paper, asbestos, canvas, cotton, nylon and glass fabric bases. Copper clad laminates for printed circuits are included. Size ranges in all grades are shown.

Circle No. 200 on Subscriber Service Card.

TEST EQUIPMENT. A four-page shortform catalog and five individual flyers describe **Cubic Corp.'s** transistorized test equipment, power measuring equipment and microwave instrumentation. The new literature includes the shortform (Bulletin 500-T), giving brief descriptions, and the individual specification sheets, giving complete data.

Cubic Model 500 Waveform Generator, a portable signal source which supplies trigger pulses, variable width gates, square waves and clipped sawtooth signals of continuously variable repetition rate and amplitude. Bulletin 510-T.

Cubic Model 504 Transistor Curve Tracer, a fully transistorized instrument for rapid evaluation of PNP and NPN Junction Triodes, which offers an eight-curve presentation, single-curve selectivity and dual input matching. Bulletin 520-T.

Cubic Model 701-B Klystron Power Supply, a compact power supply for use in development work, microwave research, production test, VSWR determination and attenuation measurement. Bulletin 530-T.

Cubic Model 100-X peakpower Test Set, a precision instrument useful for direct-reading peak power measurements of amplitude-modulated X-band sources, as an X-band signal generator with a metered power output and as a wide band crystal-video receiver. Bulletin 540-T.

Cubic Model Mc-1B Calorimetric Wattmeter, instrumentation for calibration and check-out of magnetrons and radar systems, commonly used by government and industrial laboratories as standards against which to check power-generating and power-measuring devices. Bulletin 550-T.

Circle No. 201 on Subscriber Service Card.

FM/FM TELEMETRY. **Tele-Dynamics Inc.** has just released a 24-page two-color brochure, Number 936, which describes a new line of ruggedized airborne FM/FM telemetry components. Transistorized voltage-controlled subcarrier oscillators for conventional signal voltage ranges, fractional volt ranges, and millivolt ranges are described. A compact oscillator mount, a miniature transistorized wideband amplifier, and a crystal-stabilized FM transmitter round out the equipment line-up. The brochure includes detailed electrical, environmental, and physical characteristics in addition to outline drawings.

Circle No. 202 on Subscriber Service Card.

FLAME CUTTER. An eight-page catalog on **Air Reduction's** latest addition to its line of flame-cutting machines has just been issued. Designated the Linagraph, this machine is of pantograph design and is suitable for straight line and shape cutting on eight-foot steel plate used in medium duty production. The catalog discusses in detail the design, construction and operation of the Linagraph. Liberally illustrated with photographs it explains the principal features of this automatic gas-cutting machine such as centralized operator control, pantograph design, motorized torches and its adaptability to various tracing devices.

Circle No. 203 on Subscriber Service Card.

SHAFT ASSEMBLIES. The **F. W. Steward Corporation** has issued a new catalog of its standard flexible shaft assemblies and over 180 variations which may be ordered directly from their catalog.

Circle No. 204 on Subscriber Service Card.

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since November 9 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
★AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout	Used in Discoverer program; larger model to be used with Atlas under development; NASA also will use to take place of cancelled Vega
★ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	No shots scheduled
★CENTAUR (NASA)	Convair, prime; Pratt & Whitney/JPL, propulsion	Soft-land 730-lb. on moon; first liquid hydrogen engine; 30,000-lbs. of thrust	First test flight in 1961
COURIER (ARPA-Army)	Army Signal Corps, prime	Delayed repeater communications satellite	R&D; satellite in advanced stage; first to be launched in spring
DECREE (ARPA)	No contract announced	24-hour instantaneous repeater satellite	R&D
★DISCOVERER (ARPA-AF)	Lockheed, prime; GE, re-entry vehicle	Thor-Agena launchings of early stabilized satellites	Of first 8 launched, 5 stabilized in orbit; ejected capsules not recovered
★DYNA-SOAR I (Air Force)	Boeing, space craft and systems integrator; Martin, propulsion	Boost-glide orbital space craft; first space bomber; Titan booster	R&D; first glider flights from Edwards AFB by 1962
JUNO II (NASA)	ABMA/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, prop.	Early deep space booster; small payload	Five more shots planned
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite	Capsule testing being conducted; manned capsule launching by REDSTONE down Atlantic; program slipping
MIDAS (ARPA-Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad	R&D; first launchings from Cape
MRS. V (ARPA)	No contract announced	Manueverable, recoverable space vehicle; also known as DYNA-SOAR II	Studies; future of project in doubt
NOVA (NASA)	Rocketdyne, prime; Rocketdyne, propulsion	Clustered 6 million lb. booster	Early R&D on 1.5 million lb. engines
ORION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Feasibility studies under way; tests may be attempted
★SAMOS (ARPA-Air Force)	Lockheed, prime	Reconnaissance satellite; formerly Sentry	R&D; stabilization already achieved in DISCOVERER series; first test launching scheduled this spring
★SATURN (ARPA-Army)	Army Ordnance Missile Command, prime; Convair/Pratt & Whitney, propulsion; To be transferred to NASA if Congress approves	Clustered 1.5 million lb. thrust booster; liquid TITAN or scaled-up liquid hydrogen engine second stage; CENTAUR third stage; second stage may be changed by NASA	Timetable in doubt. Under current schedule, 3-stage SATURN would be first launched late 1963 earliest; under crash program, late 1962.
★SCOUT (NASA)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Allegany/Thiokol, propulsion	Four-stage satellite launcher; 200-300 lb. payload in orbit	Operational this summer; Air Force also to use for research
STEER (ARPA)	GE-Bendix, prime	Polar-orbiting instantaneous repeater satellite	R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SUZANO (ARPA)	No contract announced	Space platform to be used as base for staging and other missions	Feasibility studies; no funding
★TACKLE (ARPA)	No contract announced	Polar orbiting communications satellite	R&D
★THOR-ABLE (NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Early deep space booster	Sun orbit shot in January
THOR-DELTA (NASA)	STL, prime; IT&T, guidance; Rocketdyne/Aerojet-General/Allegany,prop.	Put 65-lb. satellite in orbit around moon	R&D; first flight early this year; to be used in TIROS program
★TIROS (NASA-Navy)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover	R&D; three launchings this spring
★TRANSIT (ARPA-Navy)	Lockheed and Johns Hopkins Laboratory, prime	Navigational satellite	First shot almost complete failure because final stage didn't operate; next shot in February
TRIBE (ARPA)		Family of space launching vehicles	Planning
★X-15 (NASA-AF-Navy)	North American prime; Thiokol, prop.	Rocket plane; 3600 mph; flight at edge of space	Two powered flights; one plane damaged in landing
MISSILES & ROCKETS			
ABLE (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional	Deployed on destroyer escorts
ASROC (Navy)	Minneapolis-Honeywell, prime	Surface-to-underwater; solid rocket torpedo; nuclear	R&D; operational Jan. 1961
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	ICBM; more than 5500-mile range; liquid; nuclear	38 military launchings: 22 successes, 8 partial, 8 failures; 2 scientific launchings: 2 successes. Squadrons at Vandenburg
AUTOMET (Army)	No contract announced	New solid tactical missile	R&D; test vehicle stage
★ALBM (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion	Air launched ballistic missile; more than 1000-mile range; solid; nuclear	Design study stretched out
ARM	No contract announced	Anti-radar missile	R&D
★BOMARC-A (Air Force)	Boeing, prime; Westinghouse, guidance; Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid; 200 m. range; Mach 2.7; nuclear	A model operational at McGuire AFB, N.J.
★BOMARC-B (Air Force)	Boeing, prime; Westinghouse, guidance; Thiokol, propulsion	Ramjet-solid, surface-to-air; Mach 2.7; more than 500 m. range; nuclear	Late development
★BULLPUP (Navy)	Martin, prime; Republic, guidance; Thiokol (Reaction motors), propulsion	Air-to-surface; 4-mile range; conventional 250-lb. bomb; new model has pre-packaged liquid	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
★COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor	24.6-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines evaluating for purchase; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CORVUS (Navy)	Temco, prime; W. L. Maxson guidance; Reaction Motors, propulsion	Air-to-surface; pre-packaged liquid; radar homing; about 100-miles range	First successful test July 18, 1959
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
★CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
DAVY CROCKETT (Army)	In-house project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead	R&D
EAGLE (Navy)	Bendix, prime; Sanders, guidance; Aerojet propulsion	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow aircraft	Early R&D
FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional	GAR-1D & GAR-2A & GAR-3 operational; GAR-4 & GAR-9 under R&D; GAR-9 work slowed
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; units training for early deployment to Europe and Far East; advanced Hawk under development
HONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-mile range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Nearly operational; to be launched from B-52G intercontinental bombers
★JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	IRBM; liquid; nuclear	To be deployed with Italian troops in Italy and used as AICBM target drone; 27 launchings: 20 successes; 5 partials; 2 failures
★LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960; to be deployed in Europe and Far East
LITTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Operational this year; units training with it
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm	Studies
LULU (Navy)	No contract announced	Surface-to-surface; nuclear	R&D
MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
★MAULER (Army)	Convair; prime	Surface-to-air; IR guidance; field weapon	R&D
★MINUTEMAN (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; No decision other stages	2nd generation ICBM; solid; mobile; nuclear	R&D. Expected to be operational by late 1962 or early 1963; to be installed in hardened sites and made mobile on trains or trucks; tethered full-scale test vehicles successfully fired from silos
MISSILE A (Army)	No contract announced	Surface-to-surface; 65-70 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear	Rapidly replacing NIKE-AJAX
★NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol and Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D; major components being tested; first tests against ICBM's to be in PMR; first launched ZEUS fell apart in flight Aug. 26; second successful but short of programmed range, first and second stages ignited; third partial success—second stage failed to ignite
★PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; solid; 700-mile range; nuclear	R&D; to replace REDSTONE; test launchings in spring at Cape Canaveral
★POLARIS (Navy)	Lockheed, prime; GE, guidance; Aerojet-General, propulsion	Underwater and surface-to-surface; solid; 1500-mile range; nuclear	45 launchings of test vehicle; 30 successes; 12 partial; 2 failures; launched from surface ship Aug. 27, 1959; expected operational late 1960; 900-m. range vehicles under test at Cape Canaveral
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
★REDEYE (Army)	Convair, prime; Atlantic Research, propulsion	Surface-to-air; 20-lb. bazooka-type; IR guidance; solid; conventional	R&D
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe
★REGULUS II (Navy)	Chance Vought, prime; Sperry, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; used as target drone
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORAL this year
SHILLELAGH (Army)	Aeronutronics, prime	Surface-to-surface; lightweight; can be vehicle-mounted	R&D; expected to be operational mid-1960's

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional	Deployed with Navy and Air Force; all-weather type under development
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	Deployed at Presque Isle, Maine
★SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8-mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; earlier SPARROW I obsolete
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-50 mile range; solid; nuclear	R&D
SUPER TALOS (Navy)	No contract announced	Seagoing anti-missile missile; possible AICBM	Early R&D
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation by Army.
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Many test firings in Pacific; expected deployment 1960 as primary armament of guided missile destroyers; production
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England; one planned for Turkey. 56 military launchings: 37 successes; 11 partial; 8 failures; 22 scientific launchings: 19 successful, 2 partial; 1 failure
★TITAN (Air Force)	Martin, prime; Bell, Remington Rand, guidance; Aerojet-General, propulsion	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear	6 launchings test vehicles: 4 successes; 2 failures; program slipping
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

SATELLITES

SATELLITE	COUNTRY	STATUS
EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 224 m., apogee: 1573 m., period 114.8 min. (Discovered Van Allen Belt)
VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 409 m., apogee: 2453 m.
SPUTNIK III (about 3.5 tons)	Russia	Launched 5/15/58, est. life, 13 mo. Orbits earth, perigee: 135 m., apogee: 1167, period: 106 min., inclination to equator: 65.3°. Speed, at perigee: 18,837, at apogee: 14,637 mph.
LUNIK I "MECHTA" (3245 lbs.)	Russia	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle.
VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 347 m., apogee: 2064, period: 125.85 min., inclination to equator: 32.88°.
PIONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory.
EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life 10 months +. Orbits earth, perigee: 156 m., apogee: 26,357 m., period: 12½ hours, speed: at perigee 23,031, at apogee: 3126 mph., inclination to equator: 46.9°.
VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 319 m., apogee: 2329 m.
LUNIK III (about 614 lbs.)	Russia	Launched 10/4/59, orbits earth-moon; took first picture far side of moon; est. perigee: 30,000 m., apogee: 291,000 m.
EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 341, apogee: 679.
★DISCOVERER VIII	U.S.	Launched 11/20/59, est. life-short, perigee: 116, apogee: 913.

Vinton D. Carver has been named assistant general manager of Litton Industries Electron Tube Division. He will be in charge of all division operations, reporting directly to **Dr. Norman H. Moore.** Prior to joining the firm, Carver was vice president and general manager of the Pacific Division of Farnsworth Electronics Co.


CARVER

Arthur O. Wolf has been named manager of Spectron, a department of the Transducer Division, Consolidated Electrodynamics Corp.

Wolf joined the transducer division in May of this year as an administrative assistant. Previously, he spent 15 years with the Navy as a pilot and as a ground maintenance, administrative, and public information officer.

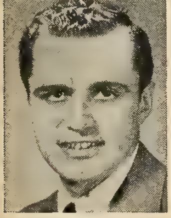
Dr. Harry E. Robbins has been selected to be a research engineer with Lessona Corp. (formerly Universal Winding Co.).

He was previously associated with the National Aniline Division of Allied Chemical Corp. as a group leader in the fiber research and development group. Prior to that, he was a supervisor in the technical department at Celanese Corp. of America.

John R. Curran, former vice president in charge of engineering, has been elected divisional vice president and general manager of the Hammel-Dahl/Foster Engineering Div. of General Controls Co., manufacturers of control valves, regulators, safety and reducing valves and flow tubes for petrochemical, atomic energy, power station, missile applications.

Curran joined the Hammel-Dahl Co. in 1945 as chief design engineer. When the company was purchased by General Controls two years ago, he was a member of the firm's board of directors and vice president in charge of engineering and sales.

Dr. Raymond R. Bouche, an authority on the calibration of vibration instrumentation, has been appointed manager, Standards and Analysis Dept., Endevco Corp. He will be responsible for transducer and electronics test procedures, maintaining electrical-mechanical standards and design of special test equipment. Dr. Bouche was with the National Bureau of Standards, Washington, D.C. for nine years, working in the field of shock and vibration measurement. He is recognized for his wide range of technical papers published in the past several years.


BOUCHE

A. H. Andrews, formerly senior engineer with Marconi, Montreal, has joined CBS Electronics as an engineering specialist in electron tube research and development.

He also served as a research engineer with Ferranti Ltd., England, where he was engaged in klystron development. Prior to that he was a cyclotron control engineer with the Nuclear Research Laboratories at the University of Liverpool.

Lockheed Missiles and Space Division has announced the following personnel changes:

Dr. Wayland C. Griffith, former associate director, has been elevated to assistant director of research and **Robert H. Gibson** has been appointed to the newly created post of production and services manager of the Navy's *Polaris* fleet ballistic missile. He was formerly stationed in Washington as assistant to the *Polaris* missile system manager.

Maurice Tucker has been named associate director of research for spacecraft and missiles and **J. R. Weiner** to associate director of information processing and computers.

Vadim N. Martinovitch has joined Stavid Engineering, Inc., as an engineering consultant in high-power modulator and radar systems design.


MARTINOVITCH

Martinovitch was formerly senior project engineer at FXR, Inc., where he was engaged in the manufacture of custom-made test equipment, high-power modulators and development of high-power pulsed radar transmitters. Earlier, he was an electrical design engineer at Vitro Corp. of America.

Dr. Norman A. Baily, an experienced radiation physicist, has joined Hughes Aircraft Co.'s nuclear electronics laboratory as a senior staff physicist. He is investigating medical and radiological applications of linear accelerators and detection devices.

Dr. Baily was formerly chief scientist for the department of radiation therapy at the Roswell Park Memorial Institute, and prior to that was scientific advisor to the Air Force on the effects of nuclear explosions on personnel and equipment and base defense problems due to special weapons.

John W. Smith has joined the ordinance division of Minneapolis-Honeywell Regulator Co. as assistant to **Clyde A. Parton,** vice president and general manager of the division. Smith was formerly associated with Collins Radio Co., where he served in various engineering capacities, most recently as engineering department head for communications systems.


SMITH

The following appointments have also been announced:

Miniature Precision Bearings, Inc., has named **Harry E. Gabriel** head of its newly opened Western Technical Center and sales office in Los Angeles. **Robert R. Pierson,** who has had extensive experience in bearing application and design work at MPB's home plant, will be in charge of the laboratory.

Carlo V. Bocciarelli has been appointed director of Philco Corp.'s research division, in charge of the basic science and technology department.

Frank B. Jewett, Jr., executive vice president, has been elected president of Vitro Corp. of America, succeeding **J. Carlton Ward, Jr.,** who has been named chairman of the board of directors. **Charles S. Payson,** the retiring board chairman, has been elected to the new office of chairman of the executive committee of the board of directors.

Thiokol Chemical Corp. has approved the addition of vice presidents **Dr. Harold W. Ritchey** and **Joseph C. Jorczak** to the board of directors.

Tung-Sol Electric Inc., has announced the election of **Frank J. Ehringer, Barton R. Lester** and **Dr. R. Burton Power, Jr.,** as vice presidents of the firm.

Donald C. Beem, formerly in charge of quality control at Owens Labs, has been named senior design engineer in charge of design and development of solid-state power supplies of the special products group of Spectrol Electronics Corp.

Lorn A. Bailey, former engineer with the Long Lines Dept. of American Telephone & Telegraph Co., has joined Page Communications Engineers, Inc., as a senior staff engineer.

Howard Cary, president of Applied Physics Corp., has been elected to Varian Associates' board of directors.

John M. Van Dam has been named general manager of the western division of Aeroquip Corp.

Glenn Cata has joined Electro-Optical Systems, Inc., as a senior engineer in the space defense systems division, where he will be engaged in preliminary systems design.

Malcolm F. "Mal" Brown, Jr., has been named to the newly created post of assistant to the vice president of engineering at Resdel Engineering Corp.

ADVANCES IN SPACE SCIENCE, Volume I. Edited by Frederick I. Ordway, III, ABMA. Academic Press, New York and London. 411 pp. $12.

This series was conceived for scientists and engineers working in the various related fields of astronautics.

It is designed to permit them to keep abreast of research and developments in their own specialties and other branches. The series is edited with the aim to the importance of the subject to the development of astronautics, the state of the art and current need and interest.

Subjects surveyed include: "Interplanetary Rocket Trajectories," "Interplanetary Communications," "Power Supplies for Orbital and Space Vehicles," "Manned Space Cabin Systems," "Radiation and Man in Space," and "Nutrition in Space Flight."

The volume also contains a proposed Decimal Classification System for Astronautics. Its purpose is to give the field a useful tool for filing references, technical papers and other material.

TIME, TACTICS, AND TECHNOLOGY, 1959 Kermit Roosevelt Lecture Program, presented by Lieutenant General Arthur G. Trudeau. Dept. of the Army pamphlet 70-15.

The research and development effort being made in the free world is covered in a series of lectures presented to British Military Schools. Emphasis is on the importance of time, tactics, science and technology.

The four lectures covered: "Research and Development-Crucible for the Future," "New Dimensions in Tactics, Weapons, and Material," "Men, Machines, and the Battlefield," and "Science and Technology."

SCIENTIFIC MANPOWER 1958, papers of the Seventh Conference on Scientific Manpower. National Science Foundation, 1951 Constitution Ave., Wash, D.C.

The report is the third in a series of annual summaries of developments relating to scientific manpower.

It contains the papers of the annual Scientific Manpower Conference held during the meeting of the American Association for the Advancement of Science.

Partial contents include: "Trends in Industrial Requirements for Scientists and Engineers," "Requirements of the Federal Government for Scientists and Engineers," "Influence of Government on the Demand for Scientists and Engineers" and "An Analytical Model for Studies of the Recruitment of Scientific Manpower."

GUIDE TO THE SPACE AGE, by C. W. Besserer and Hazel C. Besserer. Prentice-Hall, Inc., 320 pp. $7.95.

More than 5000 words and phrases are defined in this comprehensive presentation of terminology of missiles, rockets and astronautics. Terms are alphabetically arranged, extensively cross-referenced and many are illustrated by figures and tables.

Purpose of the book, according to the authors, is to help standardize the specialized language, and secondly, to present the material in a form that will be of value to technical and non-technical people.

JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, Volume 63A, No. 3, Physics and Chemistry; Volume 63C, No. 2, Engineering and Instrumentation, and Volume 63D, No. 3, Radio Propagation. Order from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Vol. A, published 6 times per year, $4 for annual subscription; Vol. C, published quarterly, $2.25 per year, Vol. D. published 6 times per year, $2.25 annual subscription.

The Physics and Chemistry volume includes: "Multiple ionization of rare gases by electron impact," "Thermal degradation of polymers at high temperatures," "OH in the solar spectrum."

Volume on Radio Propagation includes papers on "Path Antenna gain in an exponential atmosphere," "Pattern systnesis for slotted cylinder antennas," and "A method for measuring local electron density from an artificial satellite."

ON THE THEORY OF A NON-STEADY RADIATION FIELD, V. V. Sobolev. Translated from Astronomicheskiy Zhurnal (USSR). Order 59-17527 from SLA Translation Center, The John Crerar Library, 86 East Randolph St., Chicago 1, Ill. Microfilm, $2.40. Photocopy, $3.30.

The equation describing the change in intensity of the radiation along a ray is given, together with the equation relating the energy emitted by an element of volume in the medium to the energy absorbed by that element.

From this the differential equation can be obtained to determine the function which is the ratio of the coefficients of emission and absorption.

ATOMIC ENERGY IN AVIATION. Yu N. Sushkov. Translated from Atomnaya Energiya v Aviatsii (USSR). Order 59-11921 from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. $.75.

Basic principles of nuclear-powered aircraft design are described in layman's terms.

The heating of the air by means of the heat-exchange principle is the major deficiency of atomic engines. It could be eliminated by mixing the air with gaseous, liquid, or powdered nuclear fuel which in the neutron flux in the reactor core would undergo fission and liberate heat in the entire volume of air.

Experimental prototypes can be expected in the near future.

RESEARCH ON LIQUID METALS AS POWER TRANSMISSION FLUIDS, part II, R. C. Kumpitsch, General Electric Co. for WADC, U.S. Air Force. Order PB 151876 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 196 pp. $3.

The behavior as a hydraulic fluid of liquid metal NaK-77, a eutectic alloy of sodium 23% by weight and potassium 77% by weight, was observed over the temperature range 80 to 1000°F and at cyclic pressures of 15 to 3000 psi. Bearing and construction materials and static seals were tested for effectiveness in NaK-77 under the same conditions.

Among the results, a single piston pump operating in an inert atmosphere "glove box" pumped NaK-77 to pressures of 3000 psi at 1000°F and delivered a cyclic flow rate of 0.02 GPM.

Tests identified carbide materials as most compatible in NaK-7. A high-pressure (3000 psi) and temperature (1000°F) test loop was designed to test feasibility of liquid metals for power transmission and control systems. It circulates NaK-77 at a flow rate of 1 GPM.

HETEROGENEOUS CONSTRUCTION FOR MISSILE FUSELAGES, A. T. Zahorski, for WADC. Order PB 151881 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 136 pp. $2.70.

New "heterogeneous" type fuselage structures are said to provide significant structural weight savings in missiles because there are more design options in providing paths for resisting internal forces.

The greatest advantage of heterogeneous structures is said to exist where aerodynamic heating is a factor. Other advantages over conventional designs include lower cost of fabrication and functional accessibility.

A model of a proposed fuselage was fabricated and performed satisfactorily in burst, bending, and supersonic wind tunnel tests. A full-size fuselage section of the new design is reported to have shown a 45% weight savings over a current missile fuselage. Specifications for fabricating prototype fuselages are given.

The report contains a summary of present structural design philosophies and traces the need for, and the development of, the heterogeneous concept.

SPRAY FORMATION AND BREAKUP, AND SPRAY COMBUSTION, A. E. Fuhs, Air Force Office of Scientific Research. Order PB 151645 from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. 132pp. $2.75.

A survey of the literature in the field of liquid spray behavior is given in this two-part report.

The first part discusses means for atomizing liquids. Mechanisms for jet and sheet breakup under the various environments of non burning media are probed. Subsequent distributions and the behavior of liquid drops in sprays are examined, and the application to rocket motors of sprays formed by impinging jets is considered in some detail.

The second part deals with sprays associated with the combustion process. First considered is the mixing of propellants. The empirical laws of evaporation are reviewed, both for single droplets and for sprays.

Finally, an examination of spray combustion leads to the conclusion that the combustion process is quite complex, since it involves the interaction of many physical and chemical rate processes.

propulsion engineering . . .

By JAY HOLMES

A neat hypergolic igniter . . .

for a liquid hydrogen-liquid oxygen engine is suggested by NASA's Dr. Walter T. Olson. Ignition is a bigger headache here because both fuel and oxidizer are cryogenics and must be heated well above ambient before they can be set off. At full flow, enough propellant mixture can accumulate in a fraction of a millisecond to destroy the combustion chamber on ignition.

To solve the problem, Olson suggests a small supply of liquid fluorine, which is hypergolic with hydrogen. As soon as the flame is lit, oxygen can be fed into the fluorine and gradually built up to full flow. Meanwhile, the fluorine is reduced gradually and cut off when hydrogen-oxygen combustion is going full blast. Thus a small liquid fluorine tank and a couple of valves do the ignition job. The system has worked well on a laboratory scale at NASA's Lewis Research Center, Olson told the American Institute of Chemical Engineers recently.

Handling is the biggest problem . . .

involved in using fluorine, the ultimate oxidant. Many metals, such as stainless steel, copper, brass, monel and aluminum can be used for piping if they are kept scrupulously clean.

But only metal-metal seals can be used. Fluorine reacts furiously with almost every organic compound known. Teflon is not attacked chemically but it has poor physical properties at cryogenic temperatures. Thus it can be used for O-rings and valve packings only if it does not come in direct contact with the liquid. Olson said no one has ever developed a completely satisfactory liquid fluorine pump.

Because of development progress to date, he rates hydrogen-oxygen as the most promising of the high-energy chemical fuel systems. If unexpected difficulties come up in the handling of liquid hydrogen, Olson sees the hydrazine-fluorine combination, only a few points behind hydrogen-oxygen in specific impulse, as "a string to our bow."

Promotion for Dr. Harold Ritchey . . .

is announced by **Thiokol Chemical Corp.** Ritchey, vice president of the American Rocket Society, now is vice president in Charge of Rocket Divisions, one of three major divisions of the company. He had been Vice President and Technical Director.

New ideas are still scarce . . .

in the designing of propulsion systems, some military missilemen complain. When someone brings out a new gimmick, everyone in industry rushes to imitate it, instead of trying to develop something better. Despite the general acceptance of the need for rapid change in rocket technology, these sources say there is still wide unwillingness to investigate novel methods.

No 1960 price rise . . .

is expected in average raw chemical prices, despite the upward pressure on the overall price index. Competition, rising volume and constant technological improvement have kept chemical prices down over the last decade despite rising costs of almost everything else.

As one example, the average of **du Pont** prices has actually declined since 1949. The company reports its own price index stood at 104 in 1949 and was on the way up. By 1951, it rose to 112; it hit a plateau and started down in 1954. In November, 1959, it was down to 103.4, a little below the level of a decade ago.

Of the raw materials supplied to the missile/space market, some will rise and some will fall in 1960. But the outlook is that any major cost rise will be in labor, processing costs or overhead, not in raw materials.

letters

Easily Discouraged

To the Editor:

Extensive efforts to photograph the backside of the moon set the writer to contemplating the possibility of turning the moon around, i.e. setting up a rocket to spin the moon around.

The project was abandoned when the slipstick showed that it would take a rocket with 1.7 million-billion pounds force, blasting for one year, to turn the moon around halfway.

R. B. C. Newcomb
Testing Engineer
Douglas Aircraft Company
2302 Pearl Street
Santa Monica, Calif.

A Handle for ALBM

To the Editor:

You may be interested to know that your magazine is read and enjoyed even by humble little clerk-stenos (Civil Service) in the far-off Pacific. The office in which I work (M&S Division, Ordnance Office, HQ USARPAC), at Ft. Shafter, Honolulu, receives M/R regularly and I latch onto it eagerly . . .

In the Sept. 21 issue, I noted an item mentioning that the Air Force wanted a catchy name for its air-launched ballistic missile, presently referred to as *ALBM*. Just for kicks, I began a list of all the names of rockets, missiles and satellites. Apparently the Greek, Roman and Norse gods and heroes have been just about exhausted.

So I skipped down to medieval times and wondered about the names *"Crusader"* and *"Lance."* Have they been used yet? And what about the winged horse *"Pegasus"*? . . . However, maybe the AF would prefer one more modern, say *"Stingaree"* . . . Personally, I like *Lance* the best . . .

Oh yes . . . another thought. When they've quite run out of names, they might start on the Bible. There's mighty *Samson,* you know.

Space happily yours,

Frankie B. Krzympiec
2234 Citron, Apt. O
Honolulu, Hawaii

Safety Plea from Distaff

To the Editor:

That was a splendid program (for national space objectives) you outlined in the Dec. 14 M/R editorial.

And there are some of us wives here at the Cape who would like to see your energetic campaign extended to include the design of missiles that don't explode . . .

. . . A panic program will only kill our husbands . . .

Ruth Garvin
112 E. Park La.
Cocoa Beach, Fla.

Soviet Moon Studies

Two groups of Soviet scientists have independently arrived at the same conclusion that the moon's surface is not dust-covered as has been widely accepted.

N. N. Sytinskaya of the Main Astronomical Observatory in Leningrad concludes that the visible lunar surface is composed of strongly porous, striated materials, like volcanic slag in structure. Other scientists at the Khar'kov Astronomical Observatory hold that the moon is covered with disrupted tuff-like rocks with scattered large-grain volcanic ash. Both studies present a final concept of a covering of a porous, sponge-like material, sharply striated and fragmented, very probably with sharp spikes and deep furrows.

Sytinskaya believes that this peculiar structure originated in the explosions accompanying the impact of meteorites on the lunar surface. This "meteor slag" theory is confirmed by the determination of such low values of the possible lunar atmospheric density that even micrometeorites can reach the lunar surface with cosmic velocities.

The conclusions were derived through the parallel application of several different physical methods, according to the Soviet Astronomicheskiy zhurnal, Vol. 36, No. 2, 1959.

High Strength Metal

A new material twice as strong as steel and three times as strong as aluminum has reportedly been developed by the Soviet Union, according to G. Solganik. (Yunyy teckhnik, No. 9, 1959.)

"SVAM," as the Russians call it, will be used in manufacturing industries as well as chemical, petroleum and electrical engineering, and can be combined with plastics to provide a light, strong and rigid lining material for building construction.

Vanadium Added

Vanadium added to copper and aluminum in small quantities will produce superior metals without impairing their abilities, according to Soviets Ye. M. Savitskiy and U. K. Driysemaliyev.

Copper with 0.3 to 1.0% vanadium added will improve all its mechanical properties without impairing its electrical conductivity. Addition of 7.97% V to Cu increases its hardness from 42 to 75 kg/mm^2. Addition of 3.29% V increases the tensile strength of Cu from 21 to 33 kg/mm^2. Plasticity of Cu-V alloys with a low vanadium content is higher than of pure Cu, they report.

The hardness and electrical resistance of Al increases with addition of V—up to 0.4%—with no substantial change in its other physical and mechanical properties. (*Vestnik Akademii nauk Kazakhskoy SSR,* No. 7, 1959.)

In another reputed Soviet "breakthrough," titanium has been successfully introduced into titanium-bearing stainless steel in a new alumino-thermal method. Instead of adding titanium in the form of ferrotitanium, it is used in the form of ilmenite concentrate containing approximately 42% TiO_2. The concentrate is mixed with aluminum powder, iron ore powder, and lime powder in respective amounts of 38, 19, 4, and 4 kg per ton of steel, followed by the addition of lime and fluorspar in order to thin the formed high-alumina slag. (*Metallurg,* No. 10, 1959)

Coder Design

A method of designing coders, taking into account spectrum characteristics of the signals to be transmitted and using automatic control of transmission speed, has been proposed by Russian electronics specialists.

The new method would eliminate delays in telemetering processes caused by the use of optimum coders which limit high-speed telemetry. Working on a principle similar to human reactions, telemetering systems using this method can reportedly operate with any type of modulation, though width, time and code modulation types are preferred for efficiency in terms of either narrow frequency bands or increased operating speed. (Avtomatick i telemekhanika, No. 10, 1959)

New Satellite Information

Recent information in a Soviet news journal states that the rocket-carrier of each of the Soviet earth satellites greatly exceeded 4 tons.

Instruments in Sputnik II weighed 508.3 kg; maximum height of the apogee in the launching period was 1671 km, and the initial period of revolution was 193.75 min. The satellite lasted 162 days, in which it made 2370 revolutions.

Sputnik III, launched May 15, 1958, weighed 1327 kg including its rocket carrier, and its last stage weighed 1½ tons. Maximum height of the apogee in the period of launching was 1880 km, and the initial period of revolution was 105.95 min. The satellite has completed more than 7000 revolutions and is still orbiting the earth.

Rocket launching according to the Nauka i zhizn', (No. 10, 1959) is being conducted in the "moderate latitudes" of European USSR and on the Franz Josef Islands, in "equatorial latitudes," and near the village of Mirnyy in Antarctica from on board the diesel-electric powered ship "Ob."

Millimeter-Wave Radiation

A paper by K. A. Barsukov recently published in a Soviet technical journal gives as theoretical analysis of processes in an ideal system for radiating mm-wave oscillations and counting fast particles.

Writing in the *Ahurnal eksperimental'noy I teoreticheskoy fiziki* (Vol. 37, No. 4, 1959), Barsukov outlines a system consisting of a particle accelerator and a cylindrical waveguide made of conducting material and filled with two homogeneous dielectrics whose dividing boundary is perpendicular to the z-axis.

When a charged particle travels at high speed parallel to the main axis of the waveguide, it produces two electromagnetic fields inside the waveguide as a result of crossing the boundary between the two dielectrics. According to Barsukov, the integral effect when a number of particles participate is that these two fields are sustained.

The first field is bounded by the particles and is of no immediate interest, while the second has a spatial configuration and generally produces a system of waves propagating along the z-axis of the waveguide.

Theoretically, a very high-frequency field can be produced by particles hitting the boundary surface ("transition radiation") and the magnitude of the field is proportional to the energy of the particles.

Priority Red Projects

A list of 271 top-priority Soviet projects announced by TASS includes: a plate-rolling mill for the Magnitogorsk Metallurgical Combine; the first part of the cold-rolled-sheet mill for the Novyy Lipetsk Plant; a powerful sheet mill for the Il'icha Plant in the Stalino region; and the West Siberian, Karaganda, and Cherepovets Metallurgical Plants. (Promyshlenno-ekonomichesy a gazeta, Nov. 15, 1959.)

soviet affairs . . .

By DR. ALBERT PARRY

Lithium instead of sodium . . .
is suggested in Moscow as a better element to use in triggering off the so-called "artificial comet-clouds" for future *Lunik* and *Sputnik* shoots. In his article "The Cosmic Lighthouse," printed in *Znanie—Sila,* V. G. Kurt praises the role of sodium in the recent *Lunik* performances, yet points out certain of its weaknesses.

'Not an ideal material' . . .
for a rocket's vapor tail, after all—the Soviet scientist says of sodium. Kurt, who is a staff member of the State Shternberg Astronomical Institute, points out that there is too much sodium in the sun, and that therefore the solar spectrum has gaps in ray emission where lines of sodium go through "as if the solar atoms of sodium at these particular points of the spectrum have sucked the energy away." The artificial comet tail of a *Lunik* utilizes the sun's energy from only the bottom of these gaps, and this tapped energy is a mere 5% of the normal energy of the uninterrupted spectrum.

'Shamefully too little!' . . .
exclaims Kurt. He goes on to recommend lithium as an element which is almost absent from the sun and can well serve as material for "the outer-space lighthouse." He emphasizes the fact that the sun contains some 200,000 times less lithium than sodium. Thus the solar spectrum has practically no gaps caused by lithium, and this makes lithium 20 times brighter than sodium. It is also three times lighter in weight than sodium—quite an advantage, since "each kilogram of lithium has three times as many atoms." We know that each atom of sodium disseminates one quantum of light per second. With more atoms in lithium, there is still greater brightness in a *Lunik's* lithium tail than in a sodium tail. All in all, the advantages of lithium are reckoned by Kurt as 40-fold over those of sodium.

Visual observation . . .
of a lithium cloud-tail is difficult, he concedes. Yet he emphasizes that modern photo-materials have a great sensitivity in this particular kind of picture-taking. A lithium comet-cloud can be observed with the same photo-cameras which have so far been developed for sodium comet-clouds of the *Luniks*. "All you have to do," Kurt remarks, "is install a different kind of light-filter." Future spaceships will be easily traced from the earth, he predicts. By arranging for the discharge of lithium clouds in a pattern, all along the route of a spaceship, man's impending journeys into the cosmos will be photographed in their entirety.

Who originated Soviet comet-clouds? . . .
Professor I. S. Shklovsky claims in *Komsomolskaya Pravda* that he and his staff were the first to try these "global scientific experiments," as he calls the sodium tails released by the *Luniks*. A well-known astrophysicist, in charge of the Shternberg Institute's Laboratory of Radio-Astronomy, Prof. Shklovsky relates that back in 1958 he and his assistants sent up "a geophysical rocket," which at the height of a little more than 400 kilometers released a prearranged cloud of sodium, its color golden-orange, its size "equal to the distance between the widest divergent stars of Ursa Major." The Moscow *Trud* reveals that the 70 photos taken last September of *Lunik II*'s sodium cloud by the observatories of Baku, Alma-Ata, Tbilisi and other Soviet cities were sent to Dr. Shklovsky in Moscow for close study.

The latest lithium idea . . .
may well be also Shklovsky's, as Kurt is one of Shklovsky's two chief assistants. The other is V. F. Yesipov. Watch for these names in the Soviet press as more *Luniks* or *Sputniks* are shot into space, each with its special lithium or sodium vapor cloud-tail.

missile business . . .

By WILLIAM E. HOWARD

One of the drafters of the Renegotiation Act believes there are some sound reasons today for revising his creation—and making it less painful for defense contractors. Indeed, Sumner Marcus—writing in the current *California Management Review*—implies that renegotiation might well be done away with altogether.

Here are some of the arguments advanced . . .

by Marcus, who notes that conditions have changed since the last version of the law was passed in 1951, when the objective was to recapture excess profits and to prevent unfair pricing:

- A much smaller percentage of the economy is involved in defense business, making it easier to arrive at fair pricing through regular market processes. (This is not necessarily true of the large expenditures for missiles and aircraft concentrated in one industry, he says, but military agencies are more efficient and experienced now than they were at the start of World War II. And usually there is more time for investigation and negotiation—as well as more efficient procurement techniques.

- Renegotiation can be self-defeating. Incentive-type contracts today "are likely to be more effective than renegotiation" in reducing the cost of an item to the government because they can avoid initial commitment to a fixed price.

- Savings claimed by the Renegotiation Board can be misleading. They fail to take into account what renegotiation proceedings cost the companies involved. This cost is reflected in tax collections. In addition, if the Renegotiation Board conducted its proceedings like other Administrative agencies, recoveries would be substantially smaller.

If industry has to live with renegotiation . . .

Marcus suggests modifying the sting by: 1) establishing more precise criteria for determining what constitutes excess profits; 2) requiring a statement by the Renegotiation Board setting out the important issues involved; and 3) changing Tax Court procedures.

The Marcus appraisal may well be a rallying point for a drive to revamp the law in this session of Congress.

A report just out shows delays are still plaguing . . .

the Renegotiation Board. As of last June 30, the end of FY 1959, there was a backlog of 1359 cases assigned to regional boards or pending before the full board. An undetermined number of others had not yet been assigned.

During the year, 1161 new assignments were made and 1400 were completed. Of these, 141 determinations of excessive profits were made with this result: 119 bilateral agreements between the Board and contractors allowing for the recovery of $34 million out of a total of $60 million. The Board's expenses amounted to $3 million.

From scraps of paper—Christmas money . . .

Three ingenious **Rocketdyne** employes—K. E. Walden, D. A. Meyers and J. M. Agnew—designed and developed a machine which salvages remnants of expensive oscillograph record paper (used for taking data during rocket engine static testing) by splicing them together without damaging the data surface.

For this invention the three split $7275—largest suggestion award in the company's history.

NAVY

$22,600,000—**The Martin Co.**, Orlando, for additional production of *Bullpup* air-to-surface missiles.

$1,593,505—**Kearfott Co., Inc.**, subsidiary of **General Precision Equipment Corp.**, Little Falls, N.J., for an unspecified quantity of precision gyros and accelerometers for use in connection with the *Polaris* program. (Subcontract from **General Electric Co.**).

$1,300,000—**Summers Gyroscope Co.**, Santa Monica, Calif., for spring-wound gyros destined for use in the *Bullpup* missile.

$400,000—**International Telephone & Telegraph Corp.**, for services on communication facilities in the San Francisco area.

$196,985—**Beckman Instruments, Inc.**, Fullerton, Calif., for atmosphere analyzer.

$65,000—**University of California**, for research on antennas and radiation.

$50,000—**Avco Corp., Research and Advanced Development Div.**, Wilmington, Mass., for exploratory research on the vaporization of solids.

$47,170—**University of Wichita**, for research on wind tunnel tests of ground effect machine models.

$37,000—**Martin Co.**, Baltimore, for research in biophysical aspects of photosynthesis.

$34,000—**Educational Testing Service**, Princeton, N.J., for research to analyze inter-group relations under systematically varied conditions.

$32,250—**Franklin Electronics, Inc., Communications and Control Division**, for high-speed data conversion and magnetic tape storage system.

$25,000—**Foster D. Snell, Inc.**, New York City, for research and development of a satisfactory sprayable and strippable material for use as a protective coating for aircraft, missiles and rockets.

AIR FORCE

$115,000,000—**North American Aviation, Inc., Autonetics Division**, for continued development, fabrication and test of the inertial guidance and flight control system, including ground support equipment, for the solid-fuel *Minuteman* ICBM.

$15,000,000—**Westinghouse Electric Corp.**, for radar systems capable of providing three-dimensional warning information six hours after air delivery to their sites.

$250,000—**Packard Bell Electronics Corp.**, for design, development and production of a multi-channel, ground-air-ground radio receiver.

$96,272—**Marks Oxygen Co., Inc.**, Augusta, Ga., for oxygen.

$59,908—**Electro-Mechanical Research, Inc.**, Sarasota, Fla., for telemetry ground station to be used in support of Project *WS-133A*.

$40,898—**Southern Illinois University**, for research directed toward experimental and theoretical investigations of informational feedback with respect to disrupted speech communications.

$28,800—**University of Hawaii**, Honolulu, for analysis and interpretation of satellite meteorological data gathered over equatorial, tropical and subtropical regions.

NASA

$30,959—**Research Inc.**, Hopkins, Minn., for infrared heating equipment for 3.5-ft. hypersonic wind tunnel.

ARMY

$3,540,500—**North American Aviation, Inc.**, for design and development of motors. (Two contracts.)

$3,000,000—**Western Electric Co., Inc.**, New York City, for repair parts for improved *Nike-Hercules* equipment.

$2,350,214—**Raytheon Co.**, Waltham, Mass., for three sets of *Hawk* missile field maintenance test equipment.

$2,298,247—**California Institute of Technology**, for research and development of guided missiles.

$1,249,500—**Radio Corp. of America**, Moorestown, N.J., a supplemental contract for R&D on the down-range anti-missile program.

$1,148,263—**Swanson & Youngdale Construction Co.**, Minneapolis, for construction of a guided missile assembly building and storage at Fairchild AFB, Spokane, Wash.

$500,000—**Chrysler Corp.**, Detroit, in connection with the *Jupiter* program.

$471,786—**Western Electric Co.**, for *Nike* spare parts and components. (Three contracts.)

$431,970—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering services, ground support equipment, fabrication and maintenance services in connection with *Saturn*.

$394,950—**Western Electric**, for *Nike* spare parts and components. (Two contracts.)

$316,141—**Arnoux Corp.**, Los Angeles, for services and material required for design, fabrication and installation of a ground fixed FM/FM, PAM/FM, PIM/FM telemetering data acquisition and display system.

$243,200—**Southern Constructors, Inc.**, Rossville, Ga., for construction of rocket fuel storage area and utilities for the propulsion engine test facility, Arnold Air Force Station, Tenn.

$188,920—**Raytheon Co.**, Andover, Mass., for replenishment repair parts for the *Hawk* missile system. (Two contracts.)

$129,000—**Machlett Laboratories, Inc.**, Springdale, Conn., for electron tubes.

$117,610—**Lockheed Missiles and Space Div.**, for basic studies on a new technique for harnessing solar energy.

$87,311—**Pioneer Chemical Co., Inc.**, Long Island, N.Y., for rocket engine fuel.

$80,959—**Smithsonian Institution**, Washington, D.C., for satellite tracking program.

$77,000—**Sperry Utah Engineering Laboratory Div. of Sperry Rand Corp.**, for repair parts for guided missiles.

$59,812—**Harvey Aluminum, Inc.**, Torrance, Calif., for production and engineering study.

$47,897—**Allegany Instrument Co., Inc.**, Cumberland, Md., for a ballistic computer system.

Japanese to Get *Nikes*

by an M/R Correspondent

TOKYO—The Japanese Defense Agency has decided to begin equipping the country's self-defense forces with *Nike-Ajax* ground-to-air guided missiles beginning in FY 1961.

Japan's *Nike* program will come under the jurisdiction of the Ground Self-Defense Force as a result of a compromise between it and the Air Self-Defense Force.

The two services feuded for some time over control of the *Nikes*. The Defense Agency decided in favor of the army at an interservice conference in Tokyo on Dec. 22.

Conferees chose to establish the *Nike* battalions because of the prevailing opinion that Japan's aerial defense would be inadequate even with adoption of 180 Lockheed F104J Starfighters plus 20 F-104D jet trainers.

The Defense Agency will send 271 selected personnel to the *Nike* school at Fort Bliss, Tex., in July, 1960, to begin two years of training. When they return to Tokyo, they will form the nucleus of four *Nike* battalions in the Ground Self-Defense Force.

The four battalions are expected to be set up by the end of March, 1963.

Japanese and U.S. officials are believed to have reached an informal understanding that missiles—plus all firing equipment necessary for one battalion—will be loaned to Japan without charge under the U.S.-Japan defense pact.

The first *Nike-Ajaxes* will be delivered to Japan when the first group of Japanese trainees returns in the summer of 1962. At that time, the U.S. Government will equip a full *Nike* battalion for Japan.

The first batch of Japanese trainees will consist entirely of Ground Self-Defense Force personnel, but subsequent groups will include Air Self-Defense Force members.

Explorer VII Performance Pleases NASA Scientists

WASHINGTON—The *Explorer VII* satellite is performing well and yielding significant data, according to NASA scientists.

The 92-lb. space vehicle—in orbit since Oct. 13—has been transmitting data since that time on seven major experiments. Preliminary results—some not yet fully analyzed—indicate much new information as well as substantiation and fill-in on data obtained from previous satellites.

Dr. Josef Boehm, ABMA, stated that *Explorer VII* has "achieved remarkable progress in space technology." Other members of the NASA team were equally enthusiastic.

Dr. Homer Newell, NASA, emphasized that much credit for the project's success can be attributed to cooperation between team members from ABMA, NASA, State University of Iowa, University of Wisconsin, NRL, **Bartol Research Foundation, Martin Research Institute,** Army Signal Corps, **Bulova Watch Co.,** and **Hoffman Electronics.**

No experiment could be singled out as more significant than others. Considerable new data has been obtained on radiation belts and cosmic rays. Temperature control experiments have worked well. Mechanics of the satellite operation have all proved satisfactory. All payload equipment has performed up to specifications.

Three-Dimensional X-ray Used for Parts Inspection

SAN DIEGO, CALIF.—Stereoscopic X-ray examinations discover flaws which may escape normal quality control procedures.

Engineers at the **Convair Division** of **General Dynamics Corp.** perfected the three dimensional inspection method. Two X-rays of the same piece, taken at slightly different angles with conventional equipment, form the basis of the system.

The plates are then inserted in two modified X-ray film viewers in which two mirrors are set at a 45-degree angle. The observer sights across the "V" formed by the mirrors and manipulates them to superimpose the images of the negatives.

Due to the slightly different angles at which the shots were taken, the observer "sees" the image in depth. The system permits the examination of such things as fine wires in encapsulated parts. It has been used to check out many *Atlas* components.

Parts ranging in size from a thumb tack to 289 sq. in. in cross-sectional area can be studied.

more about the missile week

• **New York—Material Service Corp.,** of Chicago, an $84-million-a-year producer and supplier of building materials, concrete products and coal, has merged into **General Dynamics Corp.** The merger agreement calls for an exchange of 2,064,516 shares of a new issue of GD Convertible preference stock, without par value, for 57,532 shares of Material Service common.

• **Washington**—The Internal Revenue Service has adopted unchanged a proposed regulation killing tax exemption on money spent for "propaganda" advertising or "lobbying" activity to defeat legislation. The new rule continues as deductible expenditures for "good will" advertising and dues to trade associations—unless a "substantial part" of the dues are earmarked for lobbying and propaganda-type advertising.

• **Washington**—The Democratic Advisory Council recommends a new military concept in which the Air Force would be divorced from participation in "limited wars" to insure they would not turn into an all-out nuclear conflict. The Army and Navy would take over the job of fighting small wars.

• **Washington**—Federal Aviation Agency Administrator Elwood P. Quesada told M/R his agency is engaged in R&D of air traffic control for manned spacecraft re-entry. He said research is in Phase 3 of FFA's program, which has about 15% of the agency's funds.

• **Groton, Conn.**—The USS George Washington SSB(N)-598—first U.S. fleet ballistic missile submarine—was commissioned Dec. 30. The 380-foot, 5400-ton sub is the first of nine designed to fire 16 *Polaris* IRBM's. It's scheduled to be operational this year. Constructed on a crash 72-hour-week schedule, the George Washington was built from an attack submarine hull cut apart in the middle and extended to accommodate the missile tube section.

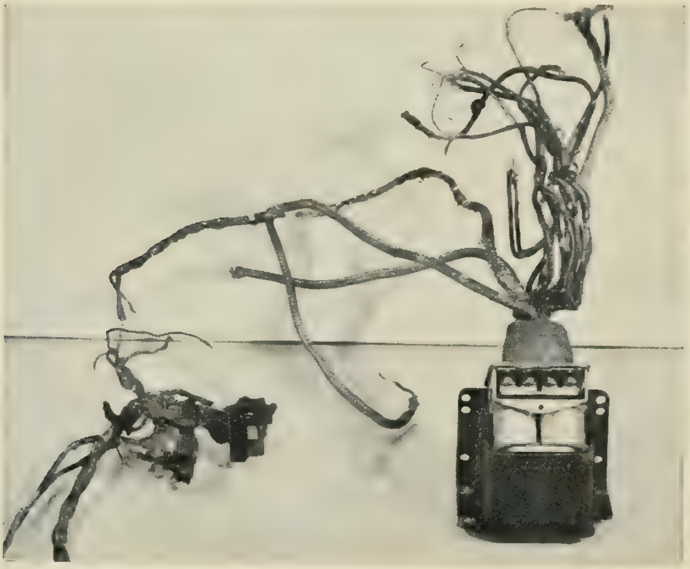
• **Groton, Conn.**—Navy's first fully transistorized fire control system will be installed in the newly commissioned *Polaris* submarine, George Washington. The complex system, made extremely compact with advanced miniaturization and packaging techniques, contains more than 15,000 transistors. Centered around a brain of both analog and digital computers, the system will provide accurate data to launch and guide the missile to its target.

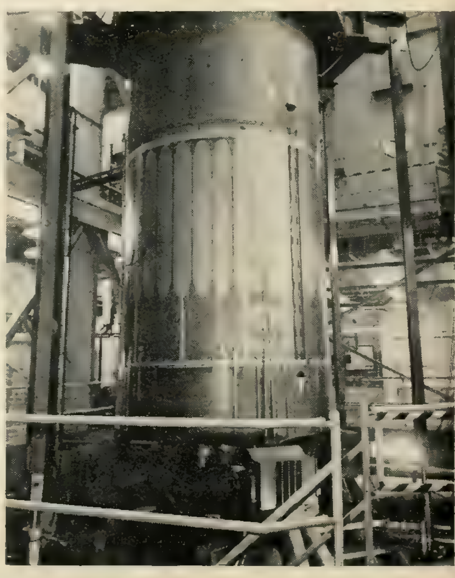
• **New York**—A new five-minute radio program, "Today in the Space Age," is being launched over a local station this week by **American Bosch Arma** to aid in the company's advertising campaign for recruiting engineers and scientists.

• **Washington**—Major missile contracts: The Omaha District Corps of Engineers has awarded **Keenan Pipe & Supply Co.,** Denver, a $4-million contract for 2056 pressure vessels for ICBM fueling systems and a $2.7-million contract to **Compu Tyne,** Hatboro, Pa., for ICBM propellant loading valves . . . **The Martin Co.,** Orlando, has received a $22.6-million follow-on award from the Navy for *Bullpup* missiles . . . and **Martin-Orlando** has awarded a $1.3-million follow-on contract to **Summers Gyroscope Co.** for spring-wound gyros for use in the *Bullpup*.

TITAN Failure Simulated in Lab

VERTICAL TEST laboratory at Martin-Denver has successfully duplicated the accidental triggering of *Titan's* safety destruct system which resulted in destruction of a *Titan-C* Dec. 12 at Cape Canaveral. Cause was chattering of an electrical relay. First-stage fuel tank, loaded and weighted to equal complete 110-ton bird, had hydraulic jacks to simulate 300,000-pound engine thrust. Explosive hold down bolts were fired releasing all forces as they occur at lift off, producing same chatter. Relay has been relocated and safety system redesigned to prevent recurrence.





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from General Electric's Defense Systems Department

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Should Ike Be Space Project Officer?

The National Space Act is a remarkable document.

It rather ridiculously made the President of the United States project officer for the nation's space program.

It created a National Aeronautics and Space Administration on the basis of program and not function—an action probably unique in major U.S. legislation.

It established a National Space Committee and a Military Liaison Committee, neither of which is effective—certainly not in the way Congress intended them to be.

Making the President responsible for Space is a little like making him responsible for oceans—or land. As the highest U.S. official and chief of the Executive Branch he presumably would have that responsibility anyway. But the National Space Act, probably in an effort to emphasize its own importance, gives him such duties as surveying and developing the program, designating responsibilities, effecting cooperation and resolving differences between agencies involved. Added to his normal duties—as Chief of State, Commander-in-Chief of the Armed Forces, etc., etc.—this seems a little too much.

The Act says NASA shall "plan, direct and conduct aeronautical and space activities." (Activities peculiar to the military are excepted.) This may be fine as a proclamation but it is difficult to follow in actuality because it is programmatic instead of functional. NASA should, let us say, have the function of *exploring* space for peaceful purposes. And if later the Department of Commerce, as an example, wants to utilize a weather satellite in forecasting, Commerce needs no special legislation to include the cost of such an operation in its budget. That is already provided because furnishing weather information for the country is a function of the Department of Commerce.

The National Space Council consists of: the President, who is chairman; Secretary of State; Secretary of Defense; Chairman of the AEC; President, National Academy of Science; Director, National Science Foundation; President, Illinois Institute of Technology, and the Administrator of NASA. Reportedly it does very little actual counseling, and this seems understandable. Many of the members are not qualified as space experts. And, more important, they have other, overriding commitments which hardly allow them to give much time or thought or understanding to the problem of competing in space.

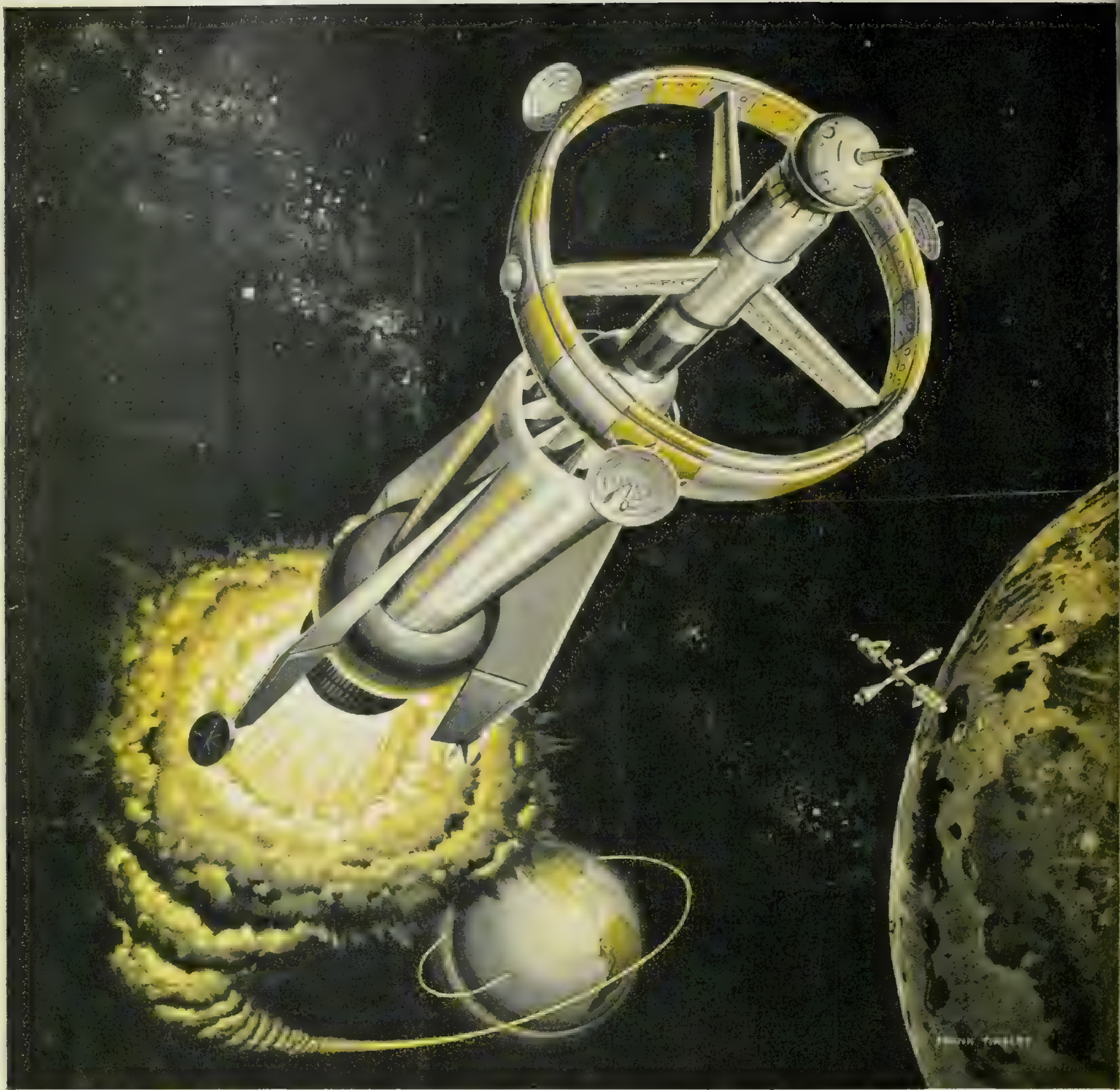
The Civilian-Military Liaison Committee is headed by a chairman named by the President and consists of representatives of the military and NASA. The Act reads that "The Administration (NASA) and the Department of Defense, through the Liaison Committee, shall advise and consult with each other on all matters within their respective jurisdictions relating to aeronautical and space activities and shall keep each other fully and currently informed with respect to such activities."

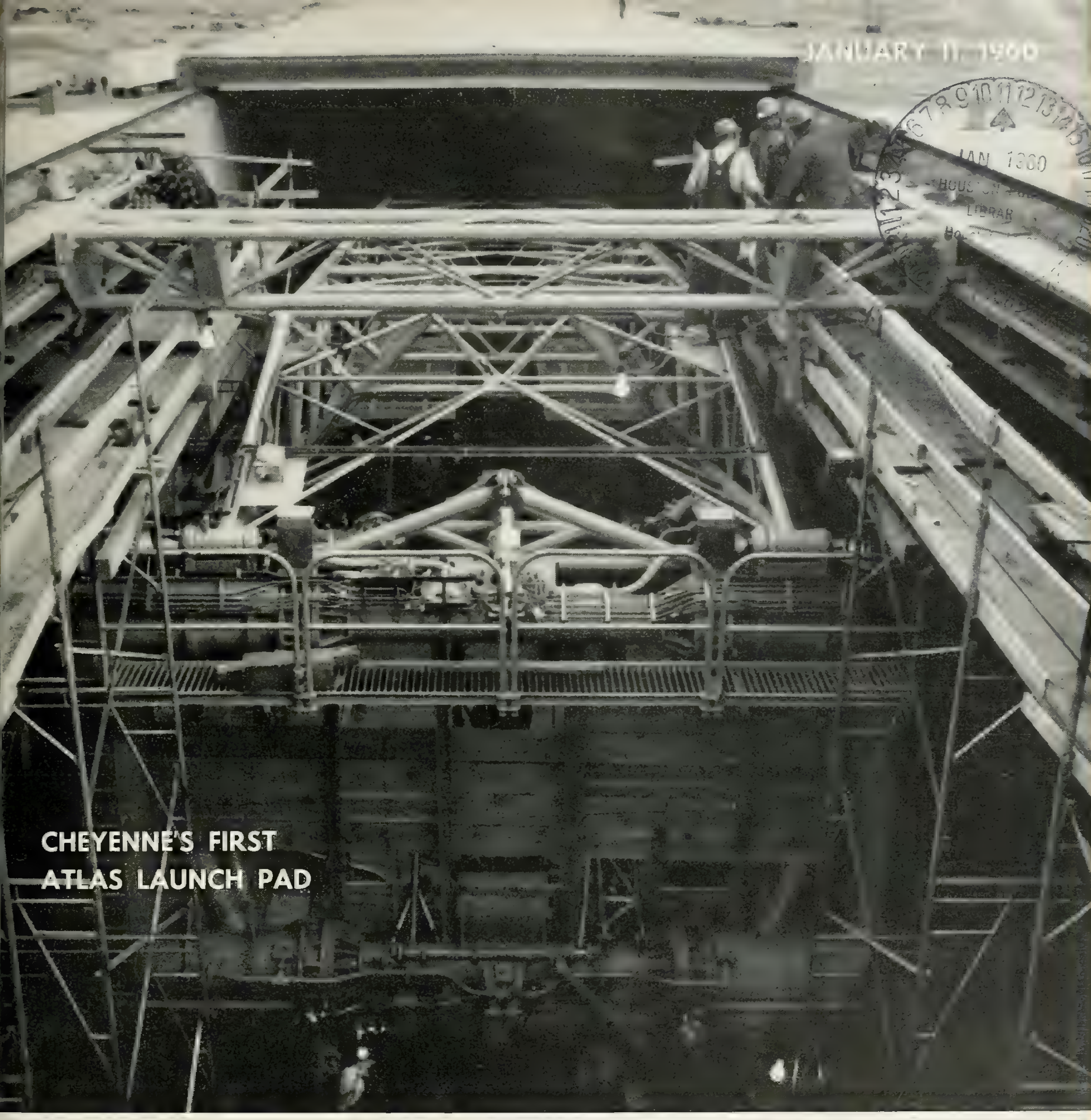
It may be one of the foibles of the American system—or perhaps just human nature—but the top people in both NASA and the military will not trust the Liaison Committee with any matters of real importance. The result is that the Committee is frequently the last to hear of significant projects or events, and usually finds itself dealing with comparative trivia.

It is not too surprising that the National Space Act leaves more than a little to be desired. It was slapped together hurriedly in the summer of 1958 when the Russians had already orbited three *Sputniks,* including one dog and kennel. Senator Lyndon Johnson, in a recent address to the Wright Day dinner, hinted that his space committee and the Congress might find some changes necessary.

We suggest a long, hard look—with some realistic revisions of the law to produce a workable system. We also suggest a new project officer.

CLARKE NEWLON





missiles and rockets

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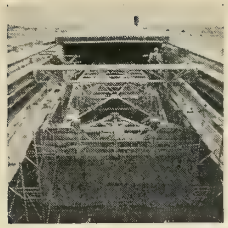
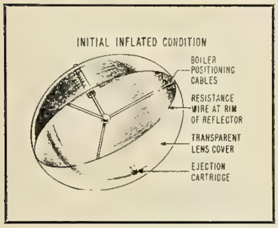
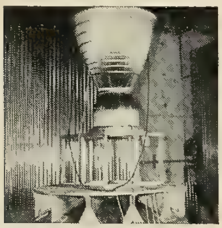


COVER: The first *Atlas* combat launching complex is nearing completion at Warren AFB, Wyo. A special report on this developing "first front" of defense begins on p. 15.



SOLAR ENERGY collector for satellite auxiliary power is envisioned in this artist's conception of one of the uses of modified Paraballoon Antennas. For a report on Westinghouse's research, see p. 21.

NEW FCA center set up by RCA at Cape Canaveral includes this varied collection of receiving antennas on its roof, to monitor and locate any signals that might interfere with missile tests. See p. 28.



THRUST CHAMBER stands on work base after brazing in GE hydrogen bell furnace at Aerojet General, which has turned out better engines with the method while sharply cutting production time. See p. 35.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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JANUARY 11 HEADLINES

ASTRIONICS

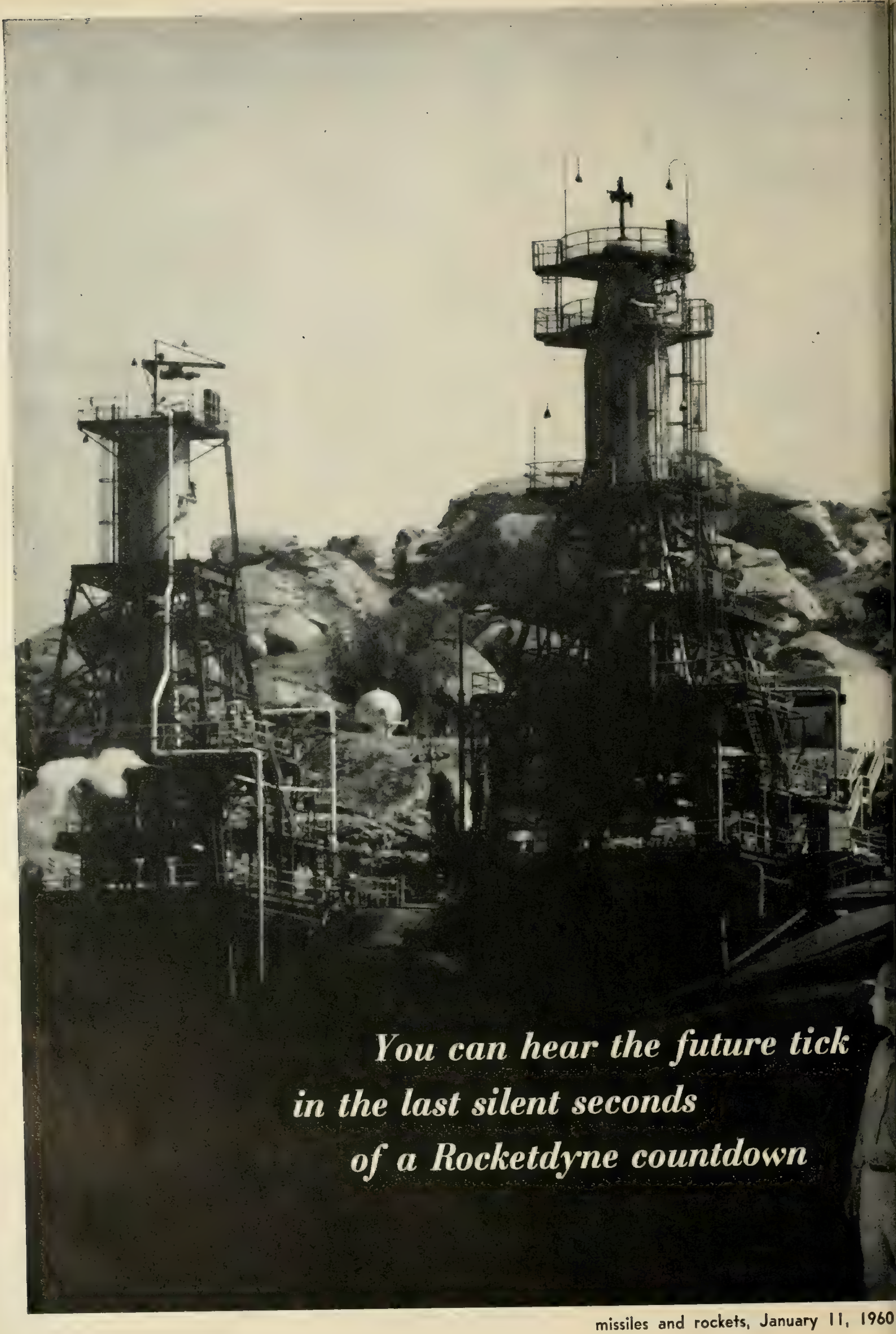
ASTRONAUTICS ENGINEERING
U.S. Reg. Pdg.

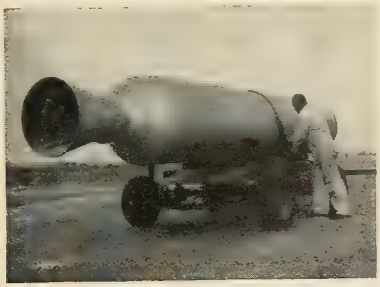
MISSILE SUPPORT
U.S. Reg. Pdg.

NEW MISSILE PRODUCTS

THE MISSILE WEEK
U.S. Reg. Pdg.

DEPARTMENTS


You can hear the future tick
in the last silent seconds
of a Rocketdyne countdown



the missile week

Washington Countdown

IN THE PENTAGON

Four new basic missiles . . .

are now called for in the Army's long-range plans for development of surface-to-surface weapons:

. . . *Missile A*—a battle group short-range missile currently being designed.

. . . *Missile B*—a division missile that would replace *Little John.*

. . . *Missile C*—a corps missile that might be an improved *Sergeant.*

. . . *Missile D*—an Army missile that might be an improved *Pershing.*

• • •

Operational Advanced *Terriers* . . .

are expected to be first deployed about mid-1960. The **Convair** surface-to-air and surface-bombardment missile is about a 100% improvement over the presently operational *Terrier.*

• • •

Tracked missile carriers . . .

are under study by the Army. The Army is particularly considering use of the chassis of **American Food Machinery's** new M-113 armored personnel carrier. Unlike Soviet missiles, all mobile Army missiles move on wheels—not tank tracks.

• • •

An operational requirement . . .

for a new tactical missile is understood to have been drawn up by the Air Force. The missile would be designed for use against jungle-based guerrillas.

• • •

Project *Spad* . . .

is the generally-used code name for ARPA-Air Force studies aimed at future development of a space-based missile defense system. The studies are being conducted by Convair and other firms. However, *Spad*—a part of ARPA's *Defender* missile defense program—is not expected to get any R&D funds in the new budget.

ON CAPITOL HILL

Senate hearings . . .

on the overall missile-space race with Russia will begin Jan. 27. They will be conducted by the Senate Space Committee and Joint Preparedness Subcommittee sitting as a joint committee. Senate Democratic Leader Lyndon Johnson is chairman of both.

The two key points . . .

that the senators will hit in the initial eight days of hearings: The Missile Gap—and what are we doing about it? . . . The Space Race—and what are we doing about it? CIA Chief Allen Dulles will be the opening witness in a closed session. All other witnesses will be heard in open sessions.

• • •

The result . . .

of sweeping House and Senate hearings on the space-missile programs is expected to be:

. . . At least some increase in U.S. space activity.

. . . The creation of a hot campaign issue.

AT NASA

$50 million plus . . .

is the latest price tag that NASA and **Western Electric** are placing on the range tracking for Project *Mercury*. The figure does not include the cost of military ships and modification of military tracking equipment.

• • •

The white paper . . .

being prepared by NASA for the Administration on the U.S. space program is expected to say that the United States does not have to compete with Russia on a launch for launch basis. At the same time, the Administration is again expected to claim that a balanced budget and other scientific projects must be taken into consideration as reasons for not going all-out on space projects.

ALONG EMBASSY ROW

New Soviet IRBM bases . . .

are reported being planned in the satellite countries of Eastern Europe. The sites would be located in Thuringia and Pomerania, East Germany; Czechoslovakia; along the Polish border in Poland, and possibly in Albania.

• • •

The first Japanese test . . .

of a surface-to-air *TLRM-2* missile was conducted at the foot of Mt. Fuji by the Japanese Defense Agency. The 24,000-foot-range missile reached an altitude of about 3300 feet.

• • •

Yugoslavia will buy . . .

10 Japanese *Kappa 6* sounding rockets for stratospheric studies. The two-stage, 17.7-foot rockets and supporting equipment will cost about $280,000.

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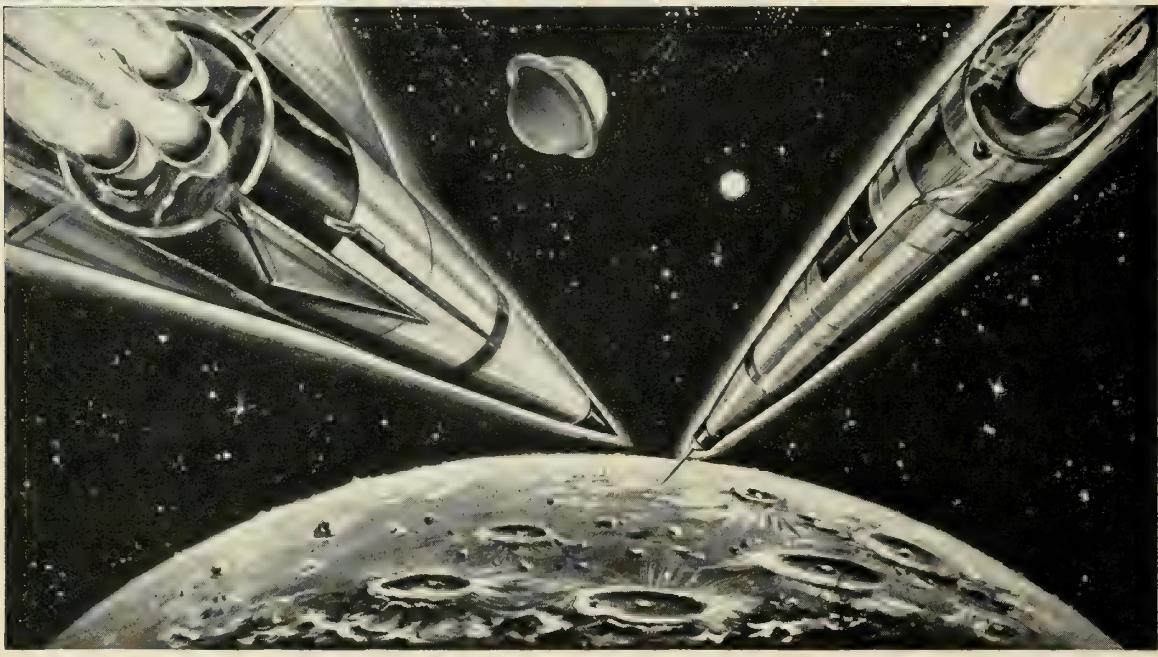

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Industry Countdown

MANUFACTURING

First attempt . . .

at developing a vertical *Titan*-like silo to launch *Atlas* ICBM's will be made at Vandenberg AFB. Corps of Engineers has just awarded a $3 million contract to **Bechtel Corp.,** an A&E firm which will design and build the single silo. If successful, it will enable the Air Force to harden future *Atlas* bases and eliminate present "soft" erector-type models (see p. 16). The test model at Vandenberg will be built near one of the training complexes and utilize its blockhouse and instrumentation.

• • •

Deal with Russia . . .

has been made by **Montecatini** of Italy to furnish the Soviets with facilities for producing titanium dioxide and acetylene—both extremely useful raw materials in the missile/space field. The contracts total $24 million.

• • •

Industry is running . . .

against interservice boundaries in the widely-publicized DOD effort to standardize missile support equipment. A recent example: the Tactical Air Command insisted upon purchasing a one-of-a-kind missile carrier-loader for a new bird even though it was told a multi-purpose loader was already in use by SAC and would do the job. TAC, it is said, "just wanted to be different."

• • •

Long-term leasing . . .

of production equipment appears to be on the upswing in the missile/aircraft industries. Those on the leasing end say that during 1959 the amount of equipment rented spurted to $21.2 million—63% ahead of the previous year. They believe their business will double this year.

• • •

New missile support . . .

directory will soon be available at the Office of Technical Services, Commerce Department. Called the "Technical Resources Directory—Ground Support Equipment for Guided Missiles," the publication lists 200 items of support equipment—most of them under development. It covers the problems of standardization, industry capability of meeting requirements and possible downgrading of specs to include commercially available equipment. The directory complements the Air Force's Technical Information File because it will provide a look-ahead at what will be available to designers and builders five years from now.

PROPULSION

Look for ion engine . . .

R&D contract proposal to be circulated by NASA in the next month or so. It will be primarily concerned with developing components, but it is believed NASA also will want an engine built under the one-year contract.

• • •

Fourth tether test . . .

of a solid-fueled *Minuteman* ICBM was successful from an underground silo at Edwards AFB, Calif.

• • •

Ultrapure hydrogen . . .

is now being produced under a low-cost diffusion process using gaseous ammonia and palladium. The developer, **Englehard Industries,** says its patented unit also will produce ultrapure hydrogen from by-product streams if the contaminants do not affect palladium.

ASTRIONICS

Jump of 37% . . .

in semiconductor sales during 1960 is forecast by industry marketing experts. Sixty per cent of the $550 million sales will be transistors—about equally split between the military and industrial consumer market.

• • •

Cross-license . . .

agreement for the manufacture and sale of semiconductors has been signed by **Philco** and **CBS Electronics.** The latter will start up two production lines to make Philco precision-etched transistors this spring.

WE HEAR THAT

Some engineering schools . . .

are worried that there will be a belt-tightening by industry this year and the demand for new graduates will fall off. . . . With new furnaces at its Omal, Ohio, plant, **Olin Mathieson Chemical Corp.** is joining the ranks of major producers of heat-treated aluminum sheet. . . . **Hexcel Products** reports it has developed an aluminum honeycomb core "15% to 30% stronger than any comparable product on today's market"—up to 100 psi/lbs./cu. ft. specific shear strength. . . . The umbilical tower for the ABMA/NASA *Saturn* vehicle may be 240 to 270 ft. high. A division of **Yuba Consolidated Industries,** Baton Rouge, La., is building the first 27-ft. section at Cape Canaveral under an $118,000 Corps of Engineers contract.

More About the Missile Week on Page 14

25-ton payload in orbit . . .

Aerojet Working On 5-Meg Solid

SACRAMENTO—**Aerojet General Corporation** is proposing a huge solid propellant booster which could place 25 tons of useful payload in orbit within eight years. The booster system, on which the firm says it is now working, would have about five million pounds thrust and be in the neighborhood of 20 feet in diameter.

Approximately $250,000 in company funds have been expended in the past year in studying the feasibility of a large solid booster, and according to the firm, "the money was well spent." All technical barriers to development have been eliminated, following thorough evaluation of the company's theory.

The multistage system is claimed to have the capability of completely surpassing liquid chemical boosters for space applications due to lower unit cost per comparable system and higher reliability per unit. Progress in solid propellants has contributed greatly to the knowledge of such systems, the company says, emphasizing that "currently existing propellants have enough impulse to do the job and possess the needed physical properties."

R. F. Tangren, manager of AGC's Applied Mechanics and Systems division at the Solid Rocket Plant, told M/R that the next five years will see the perfection of advanced propellants enabling a large-thrust solid booster to be reduced in size while still performing the mission. He added that these propellants are already in the laboratory stage.

• **Materials problems reduced**—Metal parts problems also have been reduced to a minor status by the feasibility study. The cases under consideration would utilize steels having yield strengths of more than 300,000 psi, or titanium with yield strengths above 200,000 psi. Hot shear spinning would be used to fabricate steel cases, while strip winding would be applied in titanium case fabrication.

Thrust vector control, thrust termination and other problems solved by the *Polaris* and *Minuteman* programs would not present any great difficulty to development of a 5-million-pound solid rocket system, Aerojet says. Nozzle cooling techniques now under development for use in advanced solid rocket systems would be applied to the new project.

Facilities for test and production of the multi-stage system would not require extended effort. The company states, "we simply would have to scale up existing designs."

The military and scientific applications of the system have been pointed up by Aerojet, which suggests various uses, including: placement of 25 to 50 tons of useful payload in orbit with one massive shot; boosting a manned liquid or nuclear rocket into space for variable-thrust or start/stop requirements; boosting a vehicle larger than the currently-planned *Dyna-Soar* vehicle into orbit; launching of an entire fleet of ICBM warheads, instead of a separate vehicle for each warhead; and other missions to enhance the military and scientific posture of the nation.

AGC stresses that reliability is not a function of size in solid propellant rockets, noting that field operations of 100,000 SPR units ranging from 35,000 to 115,000 pounds thrust have established a reliability rating of .9996. *Polaris* and *Minuteman* vehicles have not been included because they are still under development.

Russian *Dyna-Soar* Flying?

WASHINGTON—Russia is believed to be already flight-testing its own version of a *Dyna-Soar* space bomber.

If true, it could mean the Soviets are seven to eight years ahead of the U.S. in the development of a boost-glide space vehicle.

Disclosure of the existence of a Russian "antipodal semi-ballistic missile"—called the T-4A—was made by European military sources. These sources say the vehicle is in the advanced testing and evaluation stage. It is not yet operational, and presumably when it is, the T-4A will be manned.

There was no word as to whether the vehicle is being piloted in the tests.

However, the T-4A is said to be quite similar in design to the manned missile proposed during World War II by rocket pioneer Dr. Eugen Saenger. The Germans worked on this *Dyna-Soar* forerunner until 1942 when they abandoned it because it appeared unlikely the program would be finished in time to affect the outcome of the war.

The T-4A is described as having a maximum range of 9936 miles. The semi-ballistic course is obtained by leveling off at an altitude of 186.3 miles with a sustained velocity of 11,178 mph for 4968 miles. Maximum speed ranges up to 13,910 mph.

Payload of the T-4A is reported to be a little over one ton. The guidance system is unknown. But the vehicle is launched from a catapult propelled along a steel track by a booster of 300,000 lbs. to 360,000 lbs. thrust.

The first stage is comprised of three LOX and kerosene fueled rockets with a specific impulse of 27,000 lbs./sec. There are also two solid-fueled motors with a total of 240,000 lbs. of thrust. The sustainer develops 60,000 lbs. of thrust.

Overall length is 121.02 ft., including a main stage engine measuring 60.68 ft. in length with a diameter of 6.88 ft. Span of the wings on the reentry vehicle is 65.6 ft.

Saenger, who first envisioned his space bomber in 1933, proposed a vehicle with a take-off weight of 220,500 lbs., 92 ft. in length with a span of 49 ft. Maximum velocity was to be 13,660 mph at an altitude of 93 miles. Thrust would be 100 tons for eight minutes.

He also proposed a catapult launcher to develop a Mach 1.5 velocity before cutting in the rocket engines. Take-off weight was to be 100 tons with a 0.3 ton payload.

U.S. Air Force only last November received Defense Department permission to move ahead with the long-delayed *Dyna-Soar* program on a significant scale. Funding, however, is not on an all-out level.

Boeing Airplane is developing the spacecraft and is integrating major components. **Martin** is developing the boosters—modified *Titans*.

The Air Force regards *Dyna-Soar* as the first major step toward manned military operations in space. The U.S. version is designed to skip-glide around the entire globe on the upper layers of the atmosphere. It would be able to launch missiles or gather military intelligence and land at a site of its own choosing.

Funding at the present rate is expected to result in development of an operational U.S. system by about 1967 or 1968. However, more money could accelerate the program considerably.

Meetings Cost $21.5 Million A Year

NEW YORK—Attendance at technical meetings is costing the missile/space industry about 258,000 man-days of working time and an estimated $21,500,000 each year. And there is a serious question whether the attendants are getting enough information to make their trip worthwhile.

This is the gist of a report prepared for the Daniel and Florence Guggenheim Foundation by Pendray & Company of New York. The report also concludes that there is relatively little, if any, overlapping of specific subject matter in the meetings of the many technical societies, even though many industrial managements, and even some society executives, feel differently.

• **Other costs**—The figures still do not take into account other economic costs (arranging meetings, preparing papers, publishing programs, creating and installing exhibits, setting up hospitality suites, etc.). The report doesn't attempt to compute them because of "imponderables," but says it's "reasonable to suppose" that such additional costs might be another $1 to $3 million annually.

The report calls for the creation of a new Center for the Improvement of Technical Communications in the Flight Sciences to find "new, faster and more effective" methods of getting technical information to those who need it.

The study dealt with meetings held during the last three years by eight major technical societies: The American Rocket Society, the Institute of Aeronautical Sciences, the American Society of Mechanical Engineers, American Society of Electrical Engineers, Society of Automotive Engineers, American Institute of Chemical Engineers, and the Institute of Radio Engineers. It said that 43 national meetings by these societies in 1959 cost about $25,000 per hundred attendants, or a total of more than $21,500,000.

Two-thirds of the industrial companies queried said there were too many meetings; 85% said there was considerable overlapping and duplication. The study showed that the number of national meetings is increasing but it did not support the belief that widespread overlapping and duplication occurred. In 1959, for example, in only five instances out of 241 technical sessions (in which 986 papers and panel discussions were presented) did the same speakers appear on the programs of two or more societies with apparently the same or very similar material.

Here are some highlights of the report:

• **Attendance**—Sixty-two companies replied marking one of more of three categories: 59% *assign* technical personnel to attend; 50% *encourage* attendance; 36% *permit* attendance. No company reported that it *did not* pay travel and expenses for personnel attending.

• **Benefits**—Major benefits of attendance cited by the companies involve exchange of information, keeping up with the state of the art, etc. However, companies also pointed out that appearance by their top people enhances company prestige, allows introduction of new product ideas and concepts, calls attention to new developments, advances in company thinking, etc. Company technical groups are stimulated to better work and company morale is often improved. Many firms feel that such meetings are a handy and economical way to meet and socialize with customers in an atmosphere far different from that of the usual sales call.

• **Improvements**—Company suggestions for improving programs included: consolidating material to reduce time; eliminating duplicate subjects; more careful screening of papers to cut down the number delivered; eliminating company sales propaganda; making papers less technical; presenting only significant developments; adding more of the open forum-type sessions; making preprints available far in advance; discontinuing survey papers on space sciences by so-called "big name" speakers; and speeding up publication in society journals to reduce need for oral presentations.

more about the missile week

• **Denville, N.J.—Reaction Motors** reported advances in the development of a hybrid liquid fuel and solid oxidizer rocket engine. Company spokesmen said the results of current test programs being conducted under an Air Force contract show liquid-solid engines have high performance and controllability. They said shutdown and restart capability also has been demonstrated with the hypergolic propellant combination.

• **Washington**—Defense officials indicated that the FY 1961 defense budget would contain about $100,000 for Project *Samos*—the Air Force reconnaissance satellite program. They made clear that the failure to recover capsules from orbit in the *Discoverer* program is delaying progress on *Samos*.

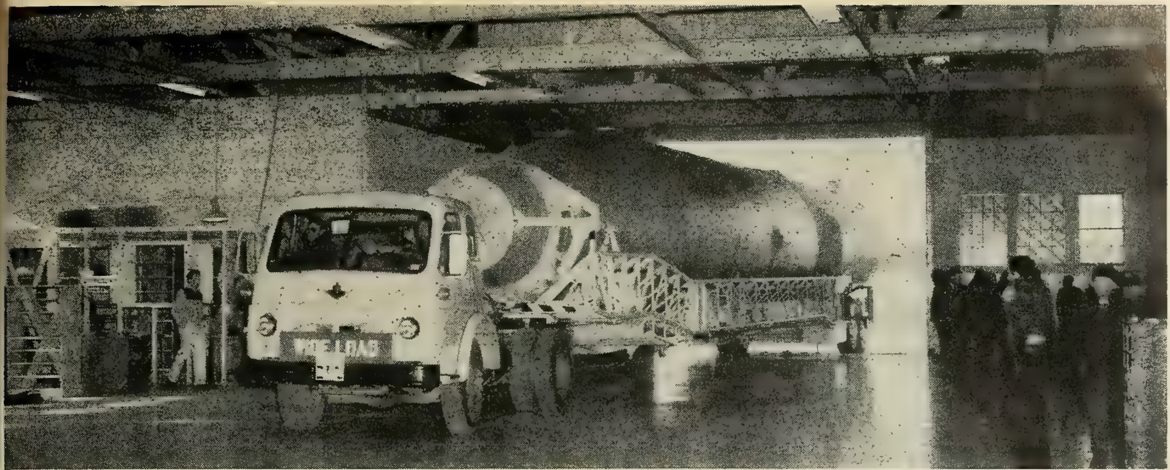
• **Huntsville, Ala.**—The Army streamlined the management of its *Nike-Zeus* program and placed it under one man—Col. John G. Zierdt, chief of staff of the Army Ordnance Missile Command. At the same time, USAF Gen. Laurence S. Kuter, NORAD commander, urged the Defense Department to reverse its decision not to begin production of the big **Western Electric** anti-missile missile.

• **Washington**—Mergers & Expansions: **Kaiser Industries Corp.** has acquired **National Steel and Shipbuilding Corp.**, a San Diego shipyard and missile parts maker . . . **Electro-Plex Corp.**, a developer of FM multiplex receiving equipment, has merged with **Nuclear Electronics**, Philadelphia . . . In its fourth acquisition in as many months, **Atlantic Research Corp.**, Alexandria, Va., has purchased **Desomatic Products**, Falls Church, Va.

• **Dayton**—ARDC's Wright Air Development Division will manage its own weapon system contracts, using computers to do most of the job. First two systems involved are the *Dyna-Soar* space bomber and WS-138A—ALBM.

• **Moscow**—Soviet "fantastiki"—Communist science fiction writers—are under attack for allowing a manned trip to the moon to fail in a recent novel. The *Literaturnaya Gazeta*—official organ of the Union of Soviet Writers—said that "fantastiki" were guilty of haboring "old mistaken concepts" since Soviet real-life rockets are already reaching the moon and beyond.

• **Washington**—Rep. Emilio Q. Daddario (D-Conn.) proposed that America's seven project *Mercury* astronauts be given government-paid $100,000 life insurance policies. He introduced the astronaut insurance bill on the opening day of Congress.



BIRDS ARRIVE at Missile Assembly Building at Warren AFB before being delivered to the combat launch sites dispersed for miles around Cheyenne. Three *Atlases* are already on the base as first sites near completion.

'from the arrow to the Atlas' . . .

The New Front—ICBM's Rise on Prairie

by James Baar and William E. Howard

(Fourth and last of a series of special reports.)

CHEYENNE, WYO.—This old cow town in the next six months will become America's front line in the Missile Age.

The nation's first truly combat ICBM base is rapidly nearing completion 22 miles to the northwest on a windswept, lonely stretch of prairie.

A century ago the principal inhabitants were Indians and buffalo. The area looked much the same until construction of the base began two years ago.

Today the first complex of three launchers at Site "A" is all but complete. The second complex of three at the same site is not far behind. Consoles and wiring are being installed in the blockhouses.

Meantime, Col. William S. Rader—commander of the 13th Air Division—is bringing together the newly trained combat missilemen who will man the base's *Atlases* around the clock. The tough, intelligent new breed of airmen are already arriving at the *Atlas* sites, checking equipment, ready to go.

One by one over the next two years 24 *Atlases* will be raised over the flat prairie in a great 60-mile wide oval around Cheyenne and adjacent Warren AFB. When completed, they will form the three squadrons of SAC's 706th Strategic Missile Wing—the first half of Rader's division.

The cost: Some $250 million.

The return: The ability to obliterate or badly damage thousands of square miles of Russia any day, any time.

• **The new front**—The atmosphere of the entire area is alive with the unreality of change and contrast.

Many missilemen and area ranchers are only beginning to realize that this soon will be the front—far more than any battle post on the Iron Curtain.

ICBM LEADER at Warren is Col. William Rader, 13th Air Div. commander.

If total war should come, this entire area and everyone in it will be Target No. 1. Russian ICBM's will pour into the area in an all-out attempt to catch the *Atlases* on the ground.

There would be a concerted effort by espionage agents to assassinate key personnel. In the hours before Russia launched an attack, agents would hope to prevent Rader and his officers from ever reaching their posts.

This, too, is the end of a mighty coast-to-coast production line.

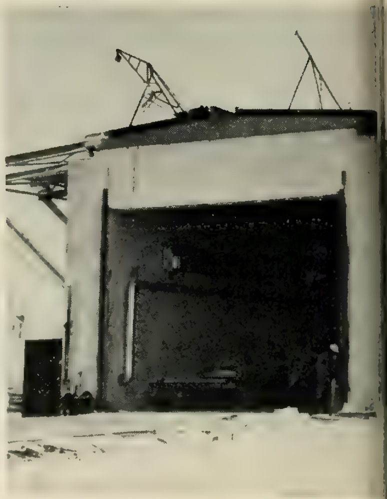
The *Atlases* that arrive from **Convair's** San Diego plant; the carriers that arrive from **Goodyear's** plant at Tucson; the automatic program checkout equipment from **RCA;** the computers from **Burroughs** are put together at the site to form the finished product—a combat *Atlas,* on site, "in the green."

This is the culmination of one of the greatest crash programs in American history—a program based on the Air Force proposition of "concurrency" which means that you must learn how to do a thing while you are doing it.

Each week the Air Force learns how to do it better. The information is passed along for future sites and bases. The book again is rewritten.

• **Coffins in the snow**—Meantime, Warren is being converted from an old Army and onetime frontier post to a modern station capable of housing and supplying the men and equipment

FIRST *ATLAS* launcher to be operational this spring has roof which slides off lengthwise. Unit of six is "soft."



SECOND WARREN squadrons show "soft" but improved configuration of launcher.

that make up the three squadrons of a strategic missile wing.

Old barracks are being gutted and remodeled. Old training areas are being converted into supply depots for the most modern equipment.

The slogan of the 706th SMW is: "From the Arrow to the *Atlas*."

Still much remains unchanged.

Snow, as it has for centuries, caps the mountain peaks that tower 60 miles away over the plain. Snow blankets the prairie and the missile sites—some not too many miles from The Old Oregon Trail.

The air is crisp and clean as you walk across the old parade ground at Warren. Nearby are the old brick quarters once occupied by General of the Armies John "Blackjack" Pershing in that time before the great world wars when soldiers still rode horses and flying was a fad.

The combat missileman might well shake his head and find it hard sometimes to keep in mind his post out on the icy prairie.

But at Auxiliary Site "A" the six reinforced concrete launch buildings of the 564th Strategic Missile Squadron squat grey and forbidding among the snow drifts—a row of coffins pointing at Soviet Russia.

This is the first and the largest of four missile complexes being constructed at 20 to 25 mile distances from the four corners of Cheyenne. The other three—each containing three missiles to be manned by the 565th SMS—are designated Auxiliary Sites "B", "C", and "D". They are situated, respectively, to the northeast, southeast and southwest.

Warren's nine final missiles—all to be manned by the 549th SMS—will not be in a complex at all, but will be widely dispersed at single sites scattered from 37 miles due north to Chugwater, Wyo., east 60 miles to Kimball, Neb., and 50 miles south near Greeley, Colo. A construction contract was let recently by the Army Corps of Engineers for these "Hollywood hard" type emplacements which will be built flush with the ground. The nine structures alone will cost about $22 million.

• **Double guidance**—Each ICBM squadron reflects rapid changes and improvements in the design of the *Atlas,* its support and handling equipment as well as efforts to make this vast new installation less vulnerable to enemy missiles.

At Site "A" is situated the base's only guidance building and boresight towers which are required for the early **General Electric/Burroughs** radio inertial guidance system. These facilities have been eliminated in the 565th and 549th SMS by the introduction of **American Bosch Arma's** all-inertial guidance.

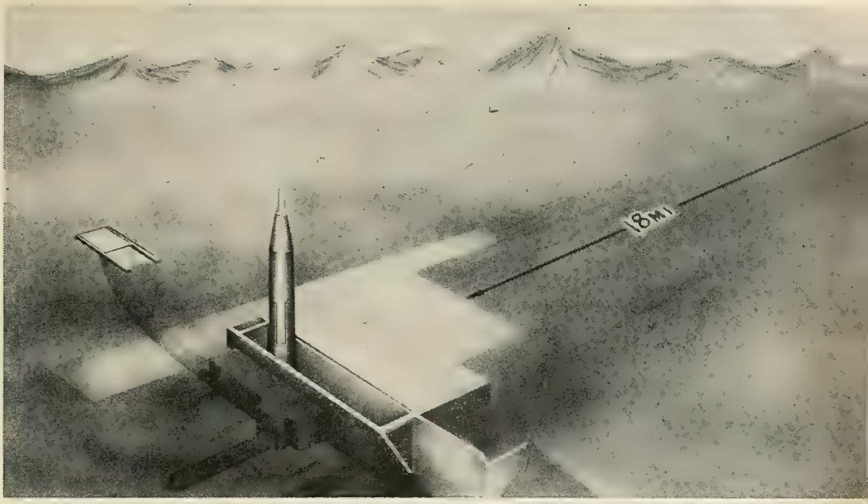
The guidance building—above ground like the rest of the facilities in the 564th (with the exception of the two earth-covered blockhouses)—stands in a depression about 4000 ft. from the group of launchers. Near it is a three-diesel generator powerplant with a capacity of 22,500 kw—enough for a city of 10,000 persons. It was designed to hold a fourth 7500 kw generator. But experts found power requirements would not be that high. Actually, the entire site can be operated with two generators—the third being held in reserve in case of a breakdown.

The guidance facility, a long one-story building with a full basement providing 30,000 sq. ft. of floor space, lies east and west. Each half of the building is a complete guidance unit capable of directing all six ICBM's to their targets. This duplication was built in to insure operation in the event half of the building is damaged during an enemy attack.

Asphalt paved roads connect all units in Site "A" which sprawls over 750 acres of prairie and is completely enclosed by a maximum security fence.

SITE "A" POWER is generated by three 7500 kw diesel generators.

Split-roof will shave crucial seconds from time required to fire ICBM.



"HOLLYWOOD HARD" type of launcher built flush with ground will be employed by dispersed squadron. Contract has been let.

There is also a patrol road which runs around the perimeter, inside the fence.

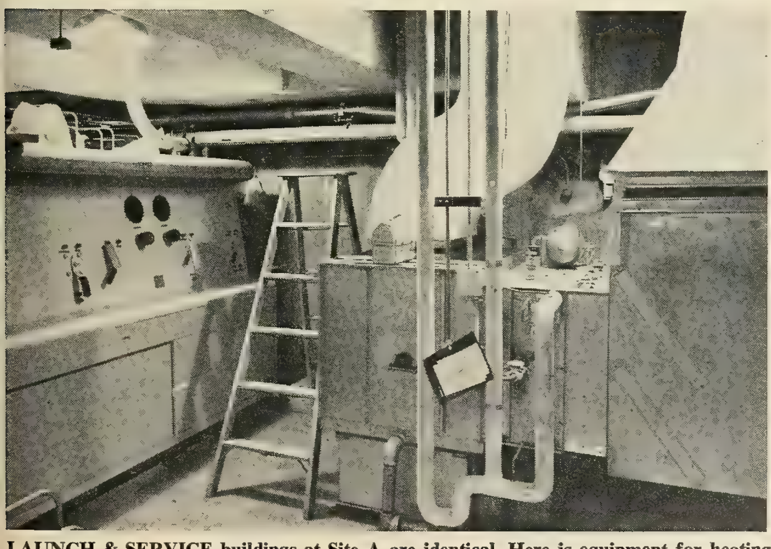
• **Fast fueling**—Today, at launcher No. 1 a wooden "whalebone" tailored to the exact outside dimensions of an *Atlas* lies in its low-slung carrier outside the door. It is being used to test the Convair erector mechanism which already is installed.

LOX tanks are filled and operational as are the RP-1 fuel tanks—all located outside the launch building. On the south side of the building along with the LOX pressure vessels are eight tanks of pressurized gaseous oxygen which is used to force the LOX into the missile's tanks. Gaseous nitrogen is used in the same manner to force in the RP-1.

Operating simultaneously, they can fuel the 260,000-lb. bird in two to three minutes.

All six launchers have wet pads and burnout pits which will permit static firing. Whether the missiles will be run up in static tests here is still a matter of debate—involving the morale of the launch crews on one hand and possible objections from neighboring ranchers over the noise and hazard.

Burnout pits also are being built into the "three by three" complexes of the 565th SMS, but will be eliminated entirely in the 549th.



LAUNCH & SERVICE buildings at Site A are identical. Here is equipment for heating the large concrete building.

Over the "coffin" storage area at Site "A" launchers is a mobile roof which slides away from the entire length of the missile on railed supports. This design has been improved in the launch buildings of the second squaddon. Here the roof is halved lengthwise and simply slides apart to open—shaving several seconds off erection of the missile into firing position.

The entire roof of the 549th SMS missile storage area will slide off to the side for the Goodyear Aircraft-designed erection mechanism to operate.

To bring Site "A" alone to its present stage of near-combat readiness has been a massive engineering job—far more complicated than anyone realized. Says one top official: "There've been thousands of change orders. So many we've lost count."

• **Ready-made facilities**— One major reason Warren was chosen to be the first ICBM site was its availability of facilities to accommodate both Air Force personnel and a civilian contractor force numbering 2200. Contractors have taken over several hundred thousand square feet of floor space in a complex of one story interconnected buildings which had housed Air Force Technical Schools. These buildings were in top condition when turned over to the missilemen.

Here—in what is known as the "missile land" section of Warren AFB —are offices and shops for **Convair Astronautics,** the prime for *Atlas;* **General Electric,** which has the re-entry vehicle as well as radio inertial guid-

ance; **Burroughs; Rocketdyne; Radio Corp. of America; Acoustica Associates; Arthur D. Little,** which is handling the cryogenic system; and **Kellogg Switchboard & Supply Co.,** a subcontractor for installing communications equipment.

Other subcontractors on the base include the **Catalytic Construction Co.,** Philadelphia, which is responsible for mechanical construction, and a sub for RCA, **Chalco Engineering,** which is working on missile and surface radars.

The responsibility for integrating construction of the various installations —the missile and its support equipment and its airborne guidance—all devolves upon Convair. GE is integrating the ground guidance system.

• **Headaches dept.**—Side by side with the contractors are field offices of the Ballistic Missile Division, headed by Col. Edwin A. Swanke; the Army Corps of Engineers, which is in charge of contracting for construction of the launch complexes, and a liaison office of the Air Material Command.

BMD is the executive agency and technical director of the program for the Air Force, which is another way of saying it handles all the headaches. For it falls largely on Swanke to "coordinate decisions" on the hundreds of engineering problems which crop up from day to day.

Installation of equipment must be planned far in advance so that one contractor won't be getting in the way of another who might be ready to run a subsystem test at the same location.

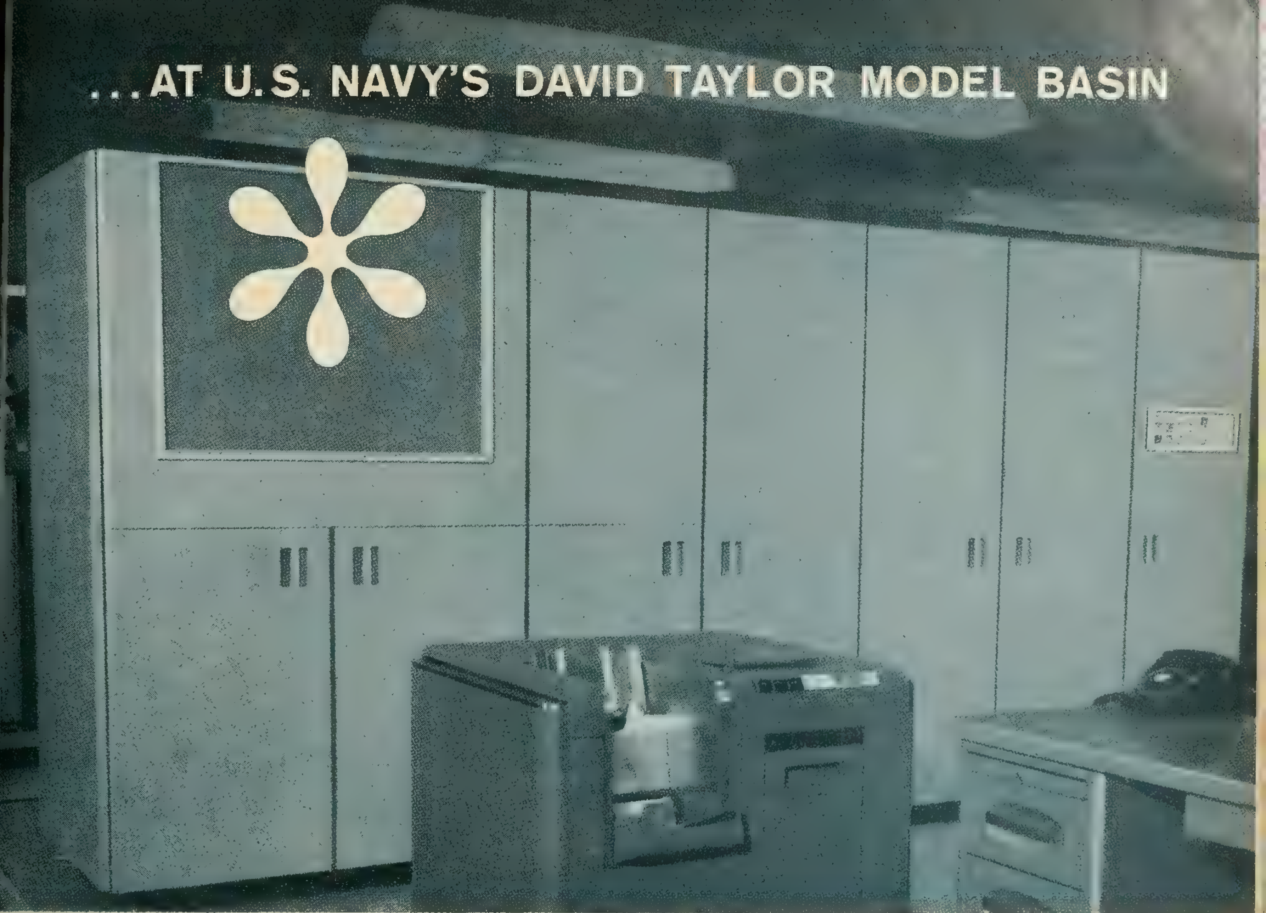
Construction of the Site "A" facility was done by the **George A. Fuller Co.,** New York. **Blount Brothers,** Montgomery, Ala., is building the three complexes of the 565th SMS, and the **Martin K. Eby Co.,** Wichita, Kan., has the contract for the nine dispersed sites of the 549th SMS. There are numerous subcontractors for installation of heavy power equipment, fuel pressure vessels, etc.

• **$250 million each**—Cost of constructing these facilities is running from $30 million to $35 million per squadron, according to the Corps of Engineers. This would bring the investment in launch facilities for three squadrons at Warren to about $100 million. Construction is estimated at about 40% of the total cost of an operational ICBM base. Thus—fully equipped and with the birds in place—the squadrons at Warren are costing about $250 million.

Rader's 13th Air Division is split into two wings—the 706th *Atlas* Wing at Warren and the 703rd *Titan* Wing at Lowry AFB, some 90 miles to the south, near Denver.

The *Atlas* Wing is backed by a maintenance squadron, a medical group and a support group. The *Titan* Wing —only now in the early stages of site

DISPERSED ICBM SITES roughly surround Warren AFB in a series of circles 15 miles apart. Numbers inside the dots marking each site signify the number of *Atlas* launchers each will have. Wide dispersion over three states makes base much harder to knock out in a surprise attack, but greatly increases problems of logistics.



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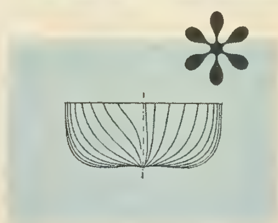

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construction—has two missile squadrons plus support and maintenance squadrons.

Each wing is centered on an Air Force base for logistical support. However, the two missile bases themselves with their widely scattered launching sites are spread over thousands of square miles.

Warren itself is a prime example of an air base in the age of the ICBM. It is becoming a vast supply, maintenance and general housekeeping center. It has no air strip at all, but uses the one at nearby Cheyenne.

Millions of dollars have been spent on "rehabbing" existing buildings at Warren AFB and in constructing new facilities. These include a huge Missile Assembly Building where six *Atlases* can be handled at one time, a technical supply building, a tightly guarded warhead building and a liquid oxygen plant. All LOX is trucked to the individual sites.

Logistic support is provided by air from a new AMC supply center set up at San Bernadino, Calif.

• **Nerve center**—The heart of this huge, complex operation will be in a command post now under construction in the MAB building at Warren. Here will be displayed the same war plans as at SAC headquarters at Omaha, and here the orders to go to war will flow.

Out on the prairie the combat missilemen will be waiting, ready to send their birds into the air within 15 minutes of the time the order is flashed.

• **The big button**—Some idea of the life and job of these combat missilemen is summed up in a remark made by a veteran combat pilot deeply involved in the program. Standing under clocks that showed the time in Moscow and Cheyenne, he said:

"What we're asking of these men is to be proficient, to maintain their equipment, to be ready to push the button day or night. And all the time they know better than anyone else that the day they push the button is the day civilization—as we know it—ends."

The men called upon to fill this role—the cream of the Air Force—are now arriving at Warren in increasing numbers to take part in installing equipment at their battle posts. This is none too soon.

No matter how hard anyone tries, complete standardization of the *Atlas* sites is impossible. Adjustments, additions, corrections are pumped into the *Atlas* program week after week. This means that the crews must continually revise what they have learned during their extensive training.

• **Getting there early**—Rader has overcome some of these problems by bringing in an installations officer to oversee what is being done. He also is trying to get his squadron commanders on the scene 18 months before a site becomes operational.

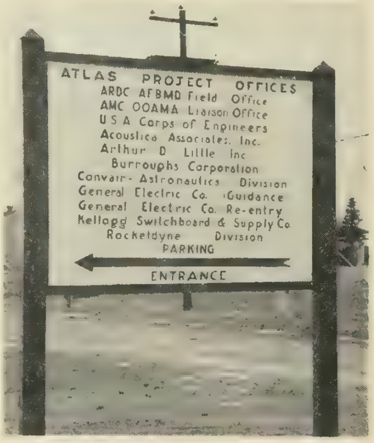
"The specs call for one thing but a contractor decides to put a cable somewhere else," he said. "Then when the time comes and I have to buy the site for the SAC, how do I know that I won't have to rip down a wall to get at the cable in an emergency? My installation officer and squadron commanders can see to it that I won't."

Personnel and supply problems caused by ever wider dispersion of ICBM sites also are posing an enormous difficulty.

It will take days for squadron commanders to visit all of their units by car. It will take hours for a missileman or replacement equipment to travel to some of the outlying sites.

The problem becomes even tougher in the winter when the blizzards that sweep the northern American plains block the roads and cut off entire areas. Because of the blizzards some excellent missile sites in the mountains west of Cheyenne had to be passed over.

ABOVE: sign indicates turnoff to first operational site 22 miles north of Cheyenne. BELOW: contractors and military work in former technical school buildings.



• **Help from whirlybird**—The solution to the command problem and much of the supply problem appears to be the helicopter. A commander in a helicopter could visit all of his units in a matter of hours. A helicopter could bring vitally-needed equipment and other supplies to a site in minutes, or be a lifesaver to a missileman suddenly stricken ill in a snowbound blockhouse.

The Air Force recently bought two **Kaman** H-43B helicopters for trial operations at Warren. The Kaman has a range of 183 nautical miles and it can cruise at 98 knots with a load of about 1500 pounds.

The Air Force sees the solution to the missileman commutation problem in staggering shifts over several days. Missilemen may be on duty at their sites for two days straight and then have three days off.

Whatever the final answer, key men will have to be kept on or close to Warren.

"For one thing we can't run the risk of having them assassinated," one officer said. "For another, we can't have people all over the lot and have to call to them and say—'why don't you drop around your missile site, we're going to war.'"

• **Too busy for boredom**—One problem the Air Force thinks it has licked is the possibility of missilemen becoming bored as they sit by their grim birds. "It just won't be a problem," one missileman said. "There's too much to do."

Another combat officer put it more bluntly: "We used to talk about putting in ping-pong tables and games. Now we wonder where to attach the broom."

Despite all difficulties, morale among missilemen from the commanders down to the missile maintenance technicians is high and growing higher by the week. All appear to feel and welcome the tension and excitement of a front line post. All have the inner confidence and nervous edge of picked troops ready to move into action.

"By giving us these missiles we are aiding the United States in gaining the time and technical know-how it needs to build space power," Rader said. "This is our guarantee of survival."

Outside the building snow had started to fall on the parade ground and the old cavalry barracks. Twenty-two miles away at Site A electricians were installing a console in the blockhouse and an airman was waxing the floor with an electric buffer. Across Crow Creek in Missileland three *Atlases* lay shrouded in the MAB, waiting to be taken to the front.

(Continued on page 38)

Paraballoon Antennas—New Space Tool

Research indicates it may be practical to use the antennas in inflatable earth satellites to do many varied jobs

by Charles D. LaFond

BALTIMORE—Balloons are back in the news with new applications and methods of ascent that would make their ancestors inflate with pride.

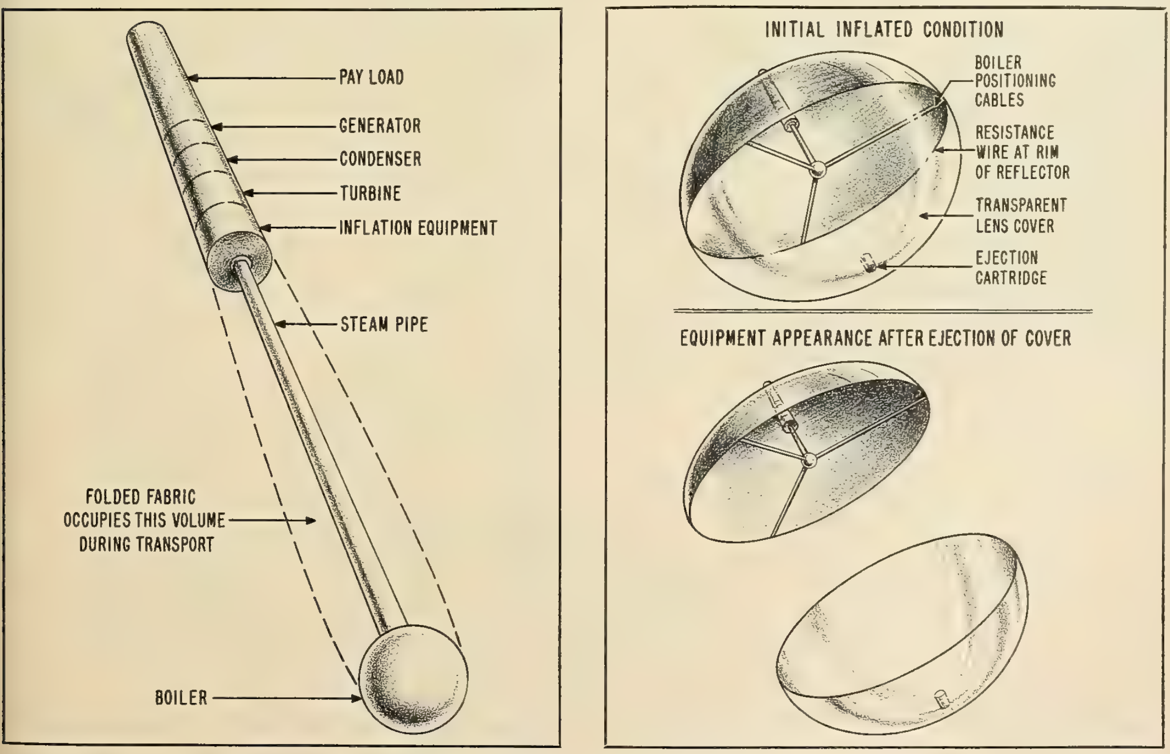
Certainly Montgolfiers, credited with construction of the first hot-air balloon in 1783, would view with awe the concept of missile-borne, pressure-erected structures for use in the earth's airless outer shell. But recent research indicates that it would be far from a "blue-sky" venture to set about using such devices for satellite auxiliary power, reconnaissance, global communications and other applications.

The feasibility of pressure-erected orbiting satellites already has been shown by the National Aeronautics and Space Administration's November shot over Wallops Island, Va. To test satellite drag at high orbital altitudes, a folded 100-foot diameter aluminum foil sphere was inflated automatically at a height of 250 miles.

Growing out of its work with communications and radar Paraballoon Antennas developed for the Air Force, the Electronics Division of **Westinghouse Electric Corp.** has maintained a company-sponsored program to develop these devices for space applications. (Already, over 70,000 engineering man-hours have been spent on development.)

The Paraballoon Antenna is a very lightweight, collapsible, radio-energy reflector. Basically an air-inflated balloon made of a flexible fabric, it is very precisely shaped and coated to provide a high-gain paraboloidal reflector in one inner portion of the skin—the remainder essentially being a window, transparent to r-f energy.

Essential characteristic of the antenna, according to Section Manager J. W. Currie, are a continued high degree of r-f reflectivity after creasing and folding, plus dimensional stability. The latter is now a negligible 0.05%



ELECTRIC POWER for an earth satellite could be obtained with this typical configuration of a pressure-erected solar energy collector. At left it is in transport condition, at right, in deployed state. (Figs. 1 & 2).

adequate performance . . .

even under severe temperature-change and load combinations. The reflecting surface is stable within ± 1/16 inch over 75% of its area and ± 1/8 inch over 95% of its area. Deviation from the theoretical paraboloid anywhere on the surface is never more than ± ¼ inch, said Currie, who believes this accuracy has not been equalled by any other method of antenna construction.

To adapt the devices for use with orbiting satellites, the company is exploiting one of the limitations of plastics (in more conventional uses)—that is, the loss of plasticizer with age.

The goal is to obtain a material that loses its plasticizing ingredients rapidly by "boil-off" when exposed to a vacuum environment. The result of this evaporation will be the stiffening or rigidizing of the vehicle material. The pressure-formed structure would then retain its shape indefinitely even after pressure dissipation.

It has been demonstrated that such structures will retain their geometric shapes under distorting forces of up to one g. In an essentially gravity-free environment where maneuvers are not violent, this performance appears to be adequate for most satellite applications.

• **Applications**—These rigid geometric configurations could be used readily for:

1) Solar energy collectors for auxiliary power sources (APS's);

2) Infrared reflectors for strategic reconnaissance, mapping and APS's;

3) Radar reflectors for long-range target acquisition or observation, and for lunar or space station jamming.

4) Worldwide communications networks.

For example, suppose it were desirable to produce a power-generating plant for the electrical equipment of a satellite with a capability of delivering 3 kw, using solar energy. This power could be generated using a flash boiler, turbine, condenser, and rotating generator—the whole system having practical efficiencies. A 30-foot paraboloidal reflector (six-foot focal length) and a transparent-film closing "window" could concentrate the required solar energy on a two-foot spherical boiler. The boiler should be coated with a material having a high solar energy absorbtivity and low infrared emissivity.

Figs. 1 and 2 show such a system in the transport and deployed conditions. The solar energy collector would be transported to its orbit in a sealed cannister containing the balloon and its deployment inflation equipment, assembled to and folded around the other units, as shown in Fig. 1. The hermetically sealed cannister would be opened and jettisoned at the time of deployment and the antenna inflated by controlled release of bottled gas. Pressure would have to be maintained long enough to allow for completion of rigidization through temperature stabilization and plasticizer evaporation.

Following inflation, the unit would be oriented toward the sun by photocells and gas jets.

After the natural rigidizing process, the supply of gas would be shut off automatically and the internal pressurizing gas allowed to diffuse through the porosity of the fabric. Next, the transparent window could be eliminated to provide a permanently unobstructed path of radiation from sun to collector (window may become cloudy after long exposure to ultraviolet radiation).

It is significant that the weight of such a 30-foot paraboloidal collector, including the transparent window, will not exceed 100 pounds, and that transport volume should be no more than one or two cubic feet.

If it is desired to concentrate solar energy near the paraboloid's vertex rather than at the focal point, a Cassegrainian reflector, as shown in Fig. 3, could be used. A somewhat longer focal length is required, but there are advantages in locating the hot body nearer the units with which it is associated in the power generation system.

• **Environment**—What would be some of the environmental factors in such a venture? During the 5 to 10-minute transit time, temperatures might range from —10° to 170°F. Actual operating temperatures of the unit would vary regularly from —100 to 250°F.

Meteorite collisions could occur once every 120 days for a mass as

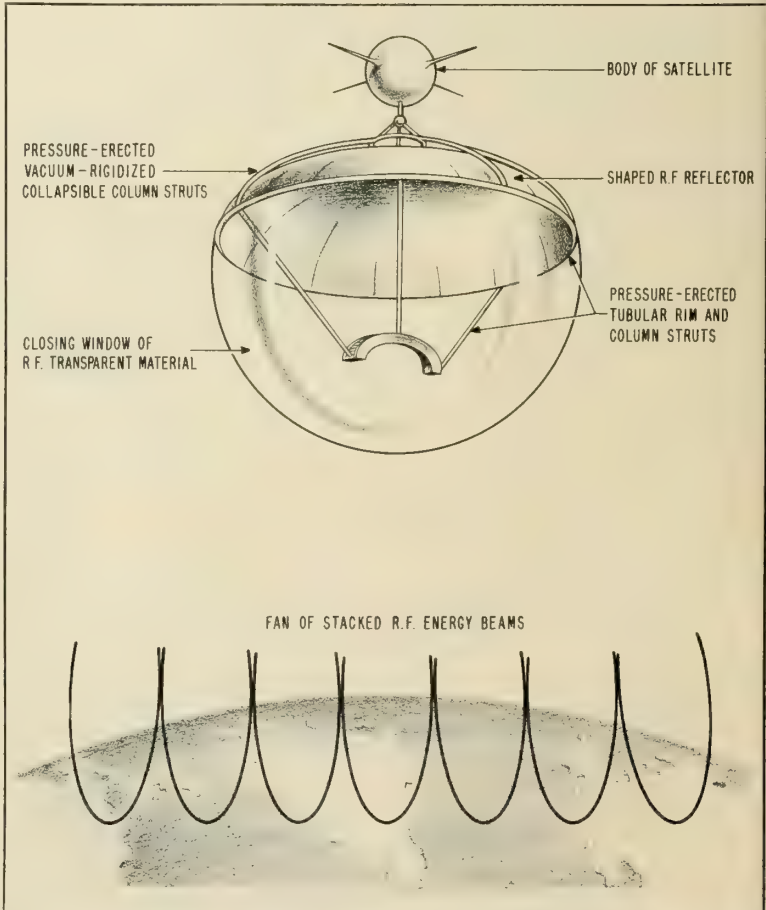


FIG. 4—Among the numerous possible applications for pressure-erected structures is this satellite configuration for a surveillance vehicle. Lightweight, collapsible radio-frequency transmission line and microwave components are also being developed.

test control and complete data

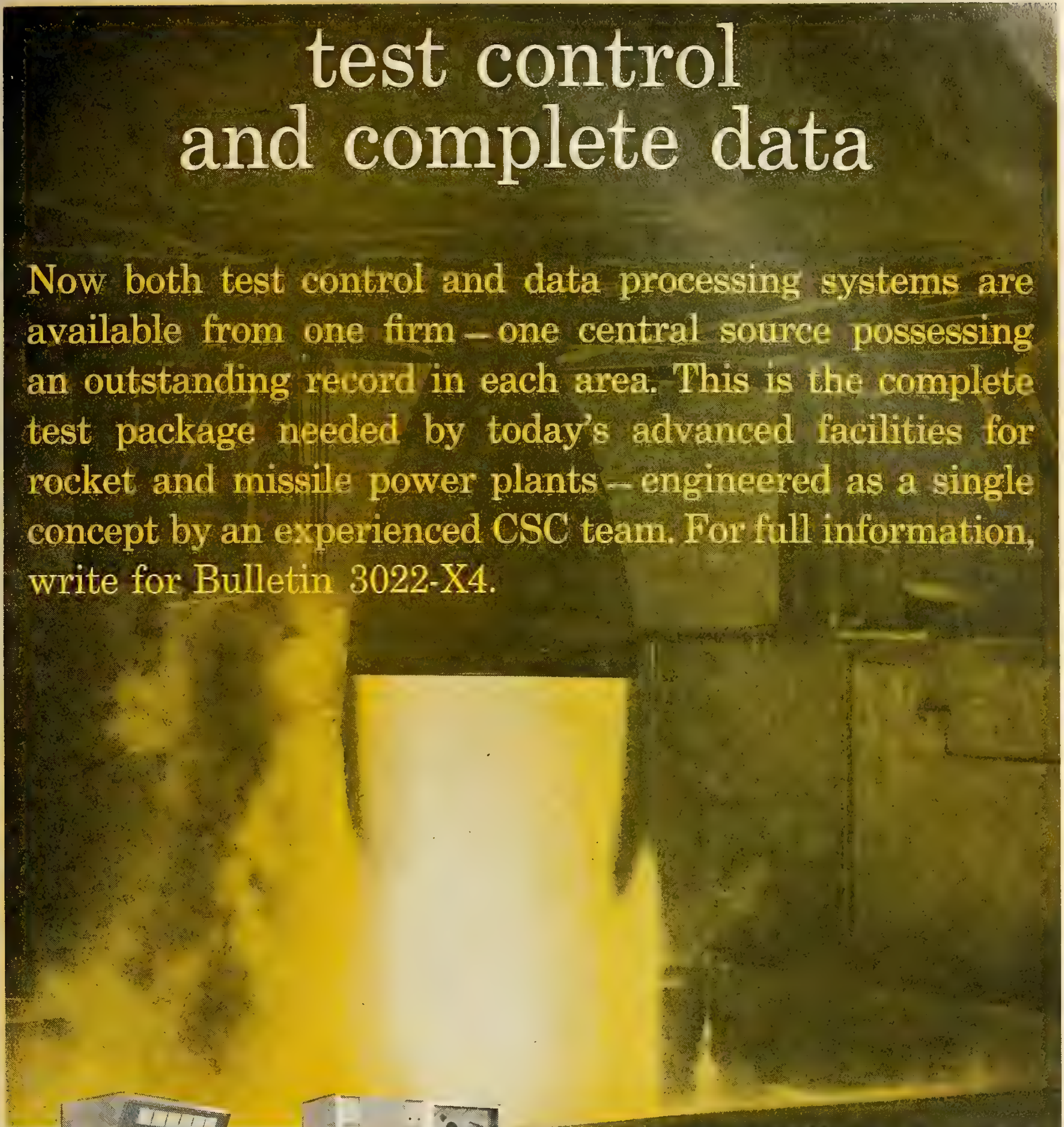


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Photo courtesy Rocketdyne, a division of North American Aviation, Inc.

The Consolidated unit shown at far left provides complete programming and control versatility over wide ranges of test conditions.

Right: CSC's new MicroSADIC high speed analog-to-digital data processor which is the heart of an instrumentation system capable of delivering data from transducers to computer.

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large as 4.0 grams, or as often as 260 times a day for 0.0006-gram masses.

Corpuscular radiation, micro-meteorites, and sublimation will cause surface erosion in time. For optical erosion to become degrading, the surface must be roughened at least to an average depth of 7/11 wavelength.

Work already performed by Westinghouse has demonstrated one advantage of the pressure-erected structure as opposed to devises which depend on rigid mechanical members. This is resistance to damage by meteorite impact.

Since the existing Paraballoon Antennas were developed to resist damage from gunfire, materials were selected which passes the most sensitive contact-fused projectile known without explosion. The only damage is the small hole made by the projectile itself.

Because the most pessimistic probability of meteorite impact must be assumed for the structure, the safest and most reliable surface is one through which the particle passes with the least disturbance. The small hole would have no measurable effect on the performance of the reflector. The efficiency of infrared and light reflectors will be decreased somewhat, but this is predictable and can be compensated in the initial design.

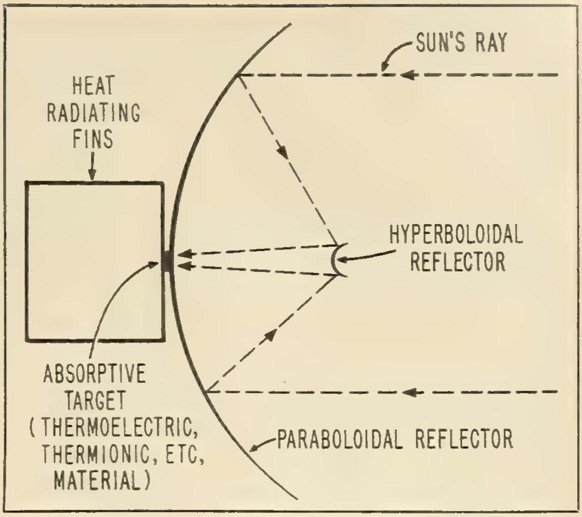

FIG. 3—A CASSEGRAINIAN REFLECTOR could be used in solar generator to locate hot body nearer to associated units in system (energy concentrated near vertex rather than at focal point.)

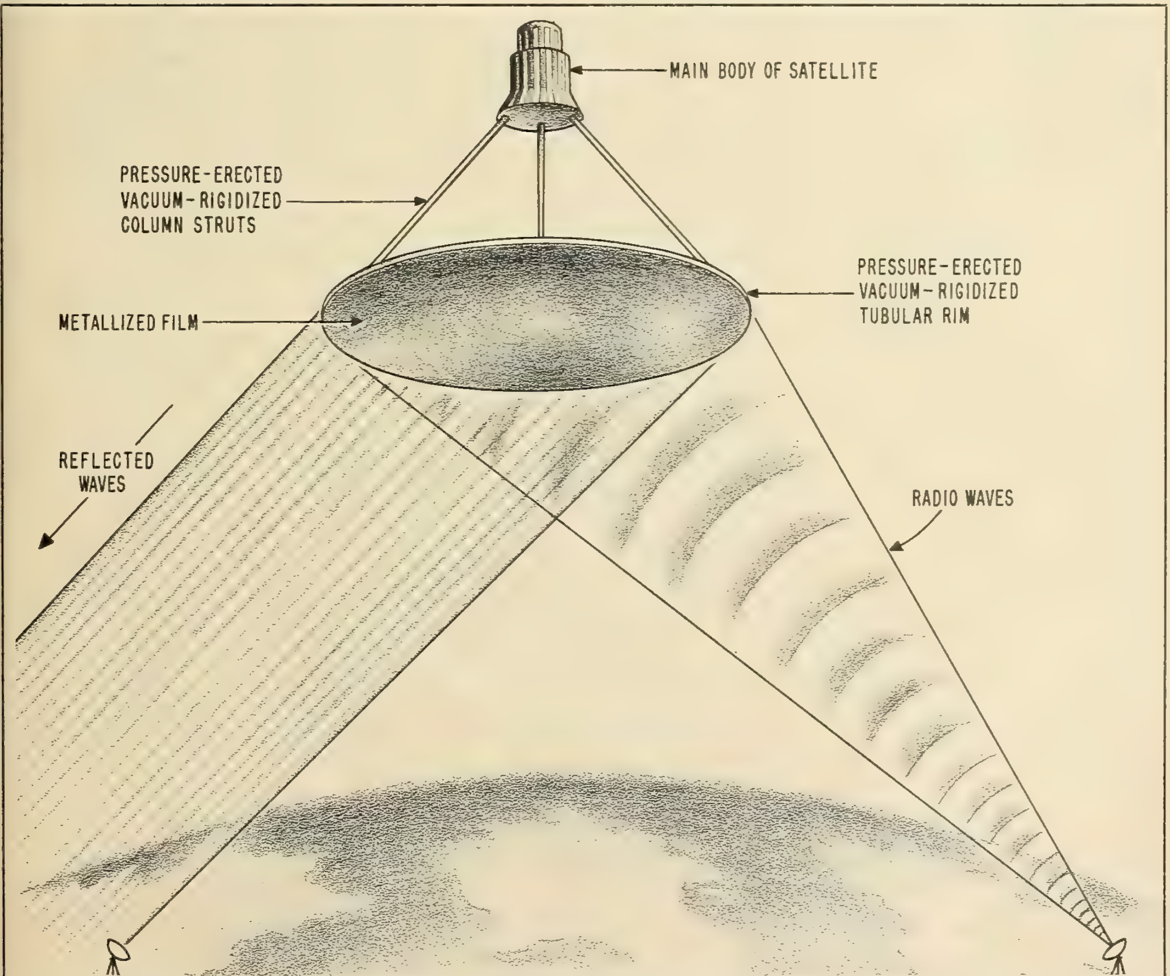

FIG. 5—Another possible application for pressure-erected structures might be in a passive communication system.

HOW FMC SERVES NATIONAL DEFENSE

FMC is one of the few companies in this country that is capable of applying coordinated mechanical and chemical research, engineering and production experience to National Defense requirements. The broad range of our company's activity in producing defense materiel is described on the opposite page.

Since 1941, FMC has designed and built more types of military-standardized tracked vehicles than any other company in America. This extensive background in the field of mobility has enabled FMC to make vital contributions to "Space Age" programs producing missile launching equipment. FMC also is a leading supplier of liquid and solid propellants, and solid propellant rocket motors for a number of advanced missile systems; also supplies pumps for atomic-powered submarines and surface vessels.

While each FMC operation can and does utilize its own creative talent and productive resources to fulfill specific needs, it may also call upon other FMC operations, as well as our central research and development laboratories. This results in specialized service backed by the total creative resources and production facilities of our company.

This progressive operating practice is the result of a long-standing policy of product diversification and decentralization of production which has made FMC a leader in three major areas: **Basic Chemicals, Industrial and Agricultural Machinery, and Military Defense Materiel.**

For complete listing of our products and services contact FMC, Dept. PRA, Box 760, San Jose, California

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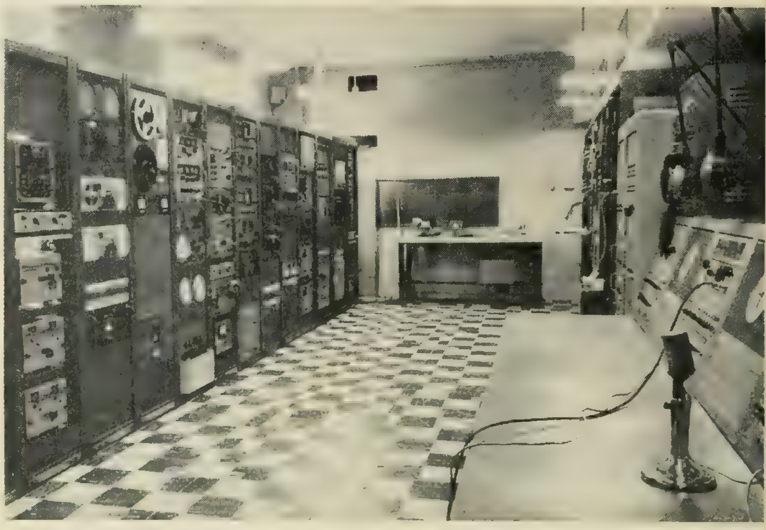
RCA Facility Fights Radio Interference



NEW FCA building at Cape Canaveral is filled with elaborate radio receiving, analysis, and direction-finding equipment to monitor entire AFMTC operating spectrum.

CAPE CANAVERAL—Operations have been stepped up in the continuing war against radio interference at the Atlantic Missile Range by the addition of the recently opened **RCA** frequency control and analysis center (FCA) here.

The FCA facility—which includes four mobile receiving and d/f vehicles and six C-131 aircraft—constantly monitors the radio spectrum from 540 kc to 10 kmc to protect missile-test radio links from interference and spurious signals. In addition, FCA also has the responsibility of monitoring and qualitatively analyzing all r-f transmissions from the Cape.

Although there are no known instances of a missile being destroyed by accidental or deliberate spurious radio signals, such emissions have caused considerable trouble in several missile tests. Many instances involve classified areas. Some which do not, and serve to illustrate the problem faced by FCA:

1) Aircraft transmissions on the 230-250 mc band, in one case, blanketed many of the Cape's telemetering receivers.

2) A *Bull Goose* test was scrubbed after a hold of almost five hours caused by radio interference which could not be located.

3) In several cases, missile beacons have been triggered by C- and X-band radar and GCA equipment.

4) Radar and telemetry antennas have lost track of missiles due to interfering signals.

Whenever interference or unauthorized transmissions appear on monitored wavelengths, the FCA group immediately locates the offending sender or equipment and silences it during the missile test. This can sometimes be accomplished from the Cape center—or it may be necessary to call in the mobile units or scramble some of the group's aircraft to pinpoint the offender.

About the only way a missile could be destroyed by radio interference would be for a false signal to be pumped into the control or command-destruct circuits. Such is not likely, due to the elaborate coding used in command transmissions to preclude the possibility. It is the vital task of FCA to see that the possibility is made even more remote, however, and that missile tests are not held up nor interfered with by random radio signals.

HEADQUARTERS building of FCA center. Facilities include four mobile ground units as well as six C-131 aircraft.

WIDE VARIETY of receiving antennas atop the FCA center monitors, locates any troublesome radio or radar signals.

'Filterscan' Data

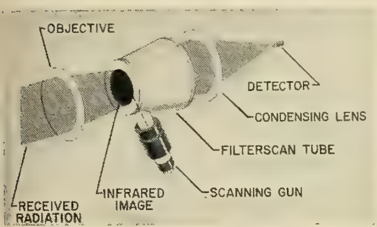
Philco's IR Scanning For Faster Monitoring

PHILADELPHIA—Although it is still under security wraps, some details of **Philco Corp.'s** newly developed "Filterscan" infrared scanning system have been released.

First reported in M/R, Oct. 26, the all-electronic IR scanner can reproduce images of fairly good quality (150-lines/inch pattern). The company has stated that if higher definition were desired for particular applications, standard TV scanning rate (525 lines/inch) could be provided.

Believed to be roughly 30 times faster than mechanical systems using oscillating-mirror scanners, electronic scanning offers capability of more rapid monitoring of changes in target direction or heat intensity.

In operation, the IR image is focussed on a tapered scanning tube which dissects the image. Window of



TYPICAL OPTICAL configuration of Filterscan as employed by the Philco Research group. The small end of the scanner is the semiconductor window.

the tube is a semiconductor; the other end is any IR transparent material.

An electron gun is connected to the scanner tube at an angle such that it allows the electron beam to strike the semiconductor window, yet keeps the beam out of the optical path between the two windows.

The image is formed on the solid-state material. When not operating the gun, IR radiation continues through the second window and is reimaged on the surface of the IR-sensitive detector.

The prototype tube developed lacks the storage capacities of a vidicon, but its construction is simple and its operation is practical when it is used with a good detector.

It has been found that photoemissive image tubes are limited by wavelength response. Vidicon or photoconductive tubes provide long-wavelength sensitivity but require extensive cooling to achieve the high resistivity required by the screen material.

Mercury Must Get More Money—Or Slip

Program originally expected to need $200 million is now likely to require about $350 million and it will drop behind schedule unless Congress comes through

ARTIST'S CONCEPTION of Project *Mercury* capsule in orbit shows view the first astronaut would get 120 miles above Cuba.

by C. Paul Means

WASHINGTON—Project *Mercury*—the space program with the highest national priority—is in financial trouble, and a strong dose of Congressional gold will be needed to keep the schedule for man's first space orbit from slipping into late 1962 or 1963.

NASA will ask for the first transfusion this month when Congress will be called upon supply close to $30 million to tide the space program through the rest of fiscal '60. Most of this money would go for *Mercury*.

The space agency presently is applying first-aid by shuffling its tight budget to come up with millions more for the project. (See M/R, Dec. 28, p. 44.) Some projects have been temporarily stopped or severely curtailed in order to supply the man-in-space effort with more money.

If Congress approves NASA's fiscal '60 supplemental budget request, it will mean that over $175 million will have been spent on the program by the end of fiscal '60, and that another $175 million will have to be spent to see the program through.

Original NASA estimates were that the program would cost only a little over $200 million.

The fact that Project *Mercury's* costs have been running well ahead of estimates has been known for some time. (See M/R, Oct. 5, p. 11.) Principal reasons for the added expense are: (1) unrealistic initial estimates; (2) rising prices, especially for construction and equipment; and (3) changes and additions to the worldwide tracking range, the capsule, and to other phases of the program.

• **$100 million more**—In rough figures, the *Mercury* program is now expected to cost about $100 million more than was originally estimated, with about half the increase due to changes and additions, and about half due to higher-than-estimated costs.

NASA Administrator T. Keith Glennan told Congress last year that the program's cost would be something over $200 million. Present estimates, according to a recent statement by NASA General Counsel John A. Johnson, are that the program will cost about $350 million.

These two figures are not comparable because certain construction and equipment costs—especially those related to the tracking range—were not originally included in the *Mercury* budget. The estimated $100 million increase—admittedly a rough figure—is arrived at by taking into account the change in NASA bookkeeping procedures and comparing the result with known increases in the program.

During fiscal '59, NASA funded Project *Mercury* for $59,463,333. Dr. Glennan told Congress last February that *Mercury's* budget for fiscal '60 would be $70 million. This total has been increased to $98,762,000 because of the inclusion of tracking funds in the *Mercury* budget, and because of

additional money transferred from other NASA projects.

Total funding for *Mercury* to date, according to a recent report by the Senate Committee on Aeronautical and Space Sciences (See M/R, Dec. 28, p. 44), is $152,198,333. If Congress approves NASA's supplemental fiscal '60 budget referred to above, total funding of Project *Mercury* by the end of this fiscal year will be about $175 million.

• **Half way**—Since present estimates indicate that $350 million in all must be spent to see the program through, Congress will have to fund the program for another $175 million in fiscal '61, fiscal '62 and possibly fiscal '63.

And if the space agency is going to come even close to the originally estimated date for launching the first U.S. astronaut into space (early 1961), most of this money will have to be appropriated for the next fiscal year. However, early reports indicate that NASA and the Bureau of the Budget are not asking Congress for anywhere near this amount.

First concrete details of the Project *Mercury* fund lag were detailed in the Senate Space Committee's report. (Available from The Superintendent of Documents, Washington 25, D.C.)

• **Greater cost**—"It is now apparent," according to the report, "that the costs of Project *Mercury* will be greater than originally estimated, particularly if NASA construction and equipment funds are taken into account."

The report points out that the investment in Project *Mercury* presently is "approximately $24 million more than the amounts previously identified to the Congress by NASA as programmed . . ." Of this, "16.4 million represents inclusion in the total of construction and equipment funds devoted specifically to the Mercury tracking network, while the remaining $7.4 million represents funds shifted from other NASA research and development programs to Project *Mercury*."

M/R has learned that among the NASA R&D projects which suffered by having money budgeted to them shifted to *Mercury* were the advanced projects studying rendezvous capability ($3 million) and orbiting laboratories ($2 million). Other construction and equipment projects have been slowed down in order to divert money to *Mercury*.

NASA, according to the report, also shuffled money from other parts of the *Mercury* project to the tracking range. Specifically, the space agency "adjusted its funding for Project *Mercury* by transferring $15 million from the 'research and development' appropriation in order to expand the *Mercury* tracking network."

• **Tracking expense**—The tracking range is one of the major portions of the *Mercury* project that is adding to its cost. Originally estimated at about $27 million, the tracking range is now expected to cost well over $40 million. This includes funds to be given to the Department of Defense for use of ships and military facilities. The program has already been funded for $31.42 million.

NASA admits that early cost estimates for the tracking range were too conservative and based on too little information. Besides higher-than-estimate costs, price has gone up because the range has been modified considerably to give it greater capabilities.

Specific changes in the range's plans have been:

• The elimination of the proposed station in the Solomon Islands;

• The addition of a station near Guaymes, Mexico to give the range the capability of bringing the capsule down after only one orbit;

• Additional telemetry to maintain a more continuous check on the astronaut's physical condition;

• Greater abort capability.

• **Capsule modifications**—Changes in the capsule and the ordering of additional capsules has also increased the cost of the program. The original contract with **McDonnell Aircraft** was for 12 identical capsules and was funded at $18.7 million. NASA has now ordered 20 capsules and has re-funded the program to $37 million.

The reason for the increased number of capsules is that NASA has given up its original idea of re-using them. Project Mercury officials think that they can learn more by tearing each capsule apart after use, and the cost of putting them back together again is almost as high as a new capsule's price.

The McDonnell capsules will be used, according to present plans atop one *Little Joe,* eight *Redstones,* and eleven *Atlases* as the project graduates from instrumented to animal loads and from animal to man.

Because of increased costs, the Mercury program is not as ambitious as it used to be. The original plan envisioned longer flights of 18 to 20 orbits and an evolution towards more advanced vehicles. The tracking range as presently constituted will not have the capability to telemeter long flights adequately, and money has been transferred from the advanced manned spacecraft programs into *Mercury*.

When will the manned capsule go aloft? This depends on how much money NASA asks for and Congress allocates, and how many technical difficulties are encountered as the program progresses.

Titan Complexes Pushed by Martin

Activation Division presses facilities work at Vandenberg and Lowry. Unusual construction techniques employed at bases

by William J. Coughlin

DENVER—**Martin Company's** new Activation Division is pushing rapidly ahead with construction of training and operational facilities for the *Titan* missile at Vandenberg Air Force Base, Calif., and Lowry Air Force Base, Colo.

With *Titan* due to become technically operational in October, equipment now is being installed in the Operational Suitability Test Facility at Vandenberg, where excavation is finished and pouring of concrete almost concluded. Martin is one of the associate contractors on the test facility, with **Space Technology Laboratories** as the integrating contractor.

In addition to the OSTF complex, Martin also is building TF-1, the *Titan* training facility at Vandenberg. On this, the company is integrating contractor and an associate contractor.

In addition to these two complexes, Martin also is believed to be involved in the construction of the Silo Launch Test Facility at Vandenberg, but the company will not confirm this. If true, it would indicate plans for early testing of subterranean launch of the Martin missile.

In addition to these projects, Activation Division is working with Air Force's Ballistic Missile Division on site surveys at Beale Air Force Base, Calif.; Larson Air Force Base, Wash.; Mountain Home Air Force Base, Idaho; and Ellsworth Air Force Base, S.D.

Martin's activation activities were established in a separate division last June, under general manager Vernon Rawlings. Permanent headquarters are in Denver, already the home of Martin's Denver division.

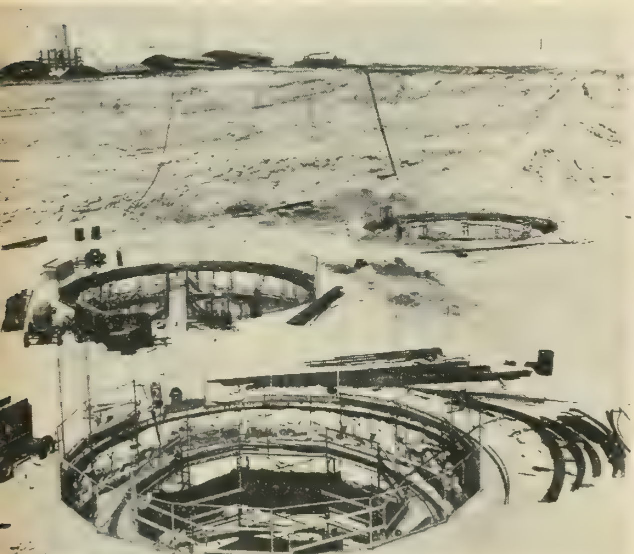
Under the Martin corporate structure, Activation is on the same administrative level as the Martin-Denver facility, where the *Titan* is built.

The company felt that the task of activating the missile bases was one of such magnitude, both from an engineering and a procurement standpoint, that it needed additional management recognition to do the job properly.

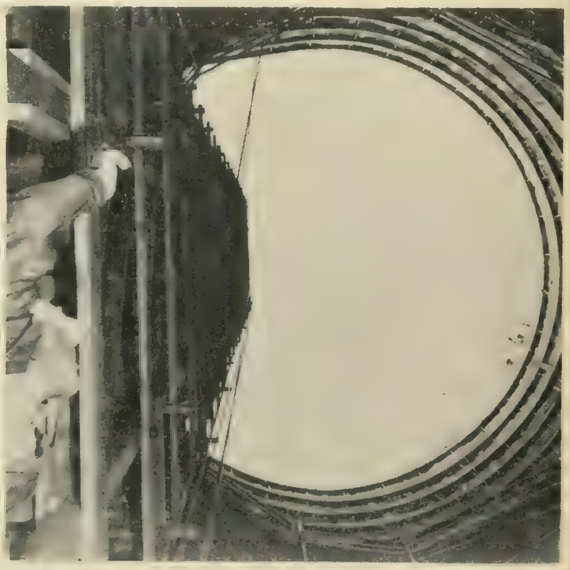
The fulltime task of the Activation Division, according to Rawlings, is "to insure the operational readiness of *Titan* launching bases to meet with Air Force schedules."

The division has some 900 fulltime employees at the moment, 580 at headquarters in Denver, the remainder in field staffs at Vandenberg and Lowry.

As additional contracts are received, the division will grow. At present, its offices are scattered on five floors of the Keith building, two floors of the Central Bank & Trust building, and one floor of the Tower building. Eventually, it is expected to have its own building.



FUEL STORAGE, missile and equipment silos at Lowry. One principal support equipment contractor is Worthington Corp.



LAUNCHING SILOS ARE 165-feet deep and have walk-through tunnels to control and maintenance facilities.

Under the Air Force's "concurrency concept," construction of bases is being pushed while the missile itself still is in the development stage. Martin's *Titan* contract, although still a research and development contract, calls for demonstration of operational capability. This includes the first base and the missiles to equip it.

Typical operational site for the *Titan* will be a hard base with all support equipment and missile silos underground. Like the **Boeing** *Minuteman*, *Titan* can be based on mobile platforms such as railway cars.

In carrying out site surveys with BMD, the Activation Division studies such problems as community attitudes, housing, labor market, transportation, medical facilities, schools, climatic conditions, city services and tax structure.

A major educational task, the division has found, is that of convincing community leaders of the need for making their town a prime target for enemy attack. A telling argument, particularly in communities accustomed to aircraft noise and associated dangers: there will be no take-offs from the missile base except in anger.

Some idea of the massive task of construction of one of these underground bases can be gained at Lowry, where initial excavation is well advanced. In actual surface launching of a *Titan*, concrete doors would slide open on the surface and the missile would be elevated from its 165-ft. deep silo to a firing position.

From each of the three silos in a squadron complex, tunnels run to adjacent propellant and equipment storage areas and to a command control center, power house, two antenna silos and an elevator shaft to the surface.

At Lowry, thousands of tons of earth are being scooped from enormous holes for each complex. After the dirt is removed—to the depth of a five-story building—deeper holes are drilled for the silo bases. The walk-through tunnels and administrative centers are constructed and the entire complex covered again with earth.

This technique differs from that used at Vandenberg, where the silo holes were drilled and then connected by tunneling.

Martin's job as integrating contractor on the Lowry site is to provide the management control necessary to assure the coordination of all contractors working under separate Air Force contracts. As one of the associate contractors, it also is responsible for engineering, installation and testing of much of the ground support equipment.

Construction at Lowry began last May; work on the site for a second SAC squadron got under way in June.

FORMS are assembled for igloo-like powerhouse and control center at Lowry.

'BADGER' machine cuts out tunnels by digging with carboloy-tipped knives mounted on an X-shaped motor attachment.

THIS 10-foot diameter tunnel was cut by specially-designed 'Badger.' Dirt is removed and carried out by a conveyor belt.

propulsion engineering . . .

By JAY HOLMES

A throttleable liquid engine

capable of operating on any thrust level between 50,000 and 150,000 lbs. has been developed for the Air Force by **Aerojet-General.** UDMH and nitrogen tetroxide make up a storable, hypergolic propellant combination. Theoretical specific impulse is 285 sec. for frozen equilibrium, 1000 psia chamber pressure, 14.7 psia nozzle exit pressure.

The engine, designated *XLR-113-AJ-1*, has a modified *Titan* first-stage injector and a film-cooled thrust chamber. It is described by Aerojet as the largest known variable thrust rocket engine on this side of the Iron Curtain.

Bursts of up to 14 seconds have been fired. Although it would have been possible to build bigger tanks and provide for longer burning, there was no such requirement under the six-month Air Force contract. The engine is designed to power rocket sleds, to be used for testing of missile components under simulated flight conditions.

In the accompanying photo, fuel feeds at the upper left and oxidizer at upper right. The diagonal tube removes drain from an actuator in the oxidizer feed. Film coolant is fed from a circumferential ring just above the drain tube.

Plastic case for a 10,000,000 lb. rocket . . .

is proposed by **Zenith Plastics Co.,** a subsidiary of **Minnesota Mining and Manufacturing Co.** Zenith says it has conceived a method of construction that removes size barriers and solves the problem of joining end closures.

A fiber glass filament-wound case for a 10,000,000 lb. thrust solid rocket could be completed on-site in two years, Zenith declared. The reference obviously is to the proposal by **Thiokol's** Dr. Harold Ritchey for a 60-second, 10,000,000 lb. booster. Zenith says its calculations were based on a requirement to handle nearly 3,000,000 lbs. of propellant. Ritchey has estimated a three-year development program.

Zenith said it has achieved a strength-to-weight ratio of 1,100,000 in. in a privately financed study of what it called "a typical motor case configuration including the closure as an integral part." In laboratory tests, Zenith researchers have achieved strength-to-weight ratios of 1,350,000 in. for semi-bidirectional and 2,210,000 in. for unidirectional wound samples.

Utah location . . .

is planned for Thiokol's new Rocket Operations. Headquarters probably will be in Salt Lake City or Ogden. Utah was obviously chosen for nearness to Thiokol's *Minuteman* R&D center at Brigham City.

Chemical market is $1.14 billion . . .

not $3.75 billion as estimated Dec. 21. Manufacturing Chemists Assn. states that the chemical industry receives 15% of the total missile/-space government spending—currently $7.6 billion.

Engines Improved by Quick Brazing

Aerojet uses GE hydrogen bell brazing furnace to turn out lighter, stronger and more reliable Titan engines—with dramatic cut in production time

by Frank G. McGuire

SACRAMENTO, CALIF.—A lighter, stronger and more reliable *Titan* engine has resulted from a new brazing method introduced into the manufacturing process by **Aerojet-General Corporation,** prime contractor for the propulsion system of the **Martin** ICBM.

Despite the advantages gained, however, there has been no increase in the time required for fabrication; on the contrary, the previous 135-hour operation now takes eight hours.

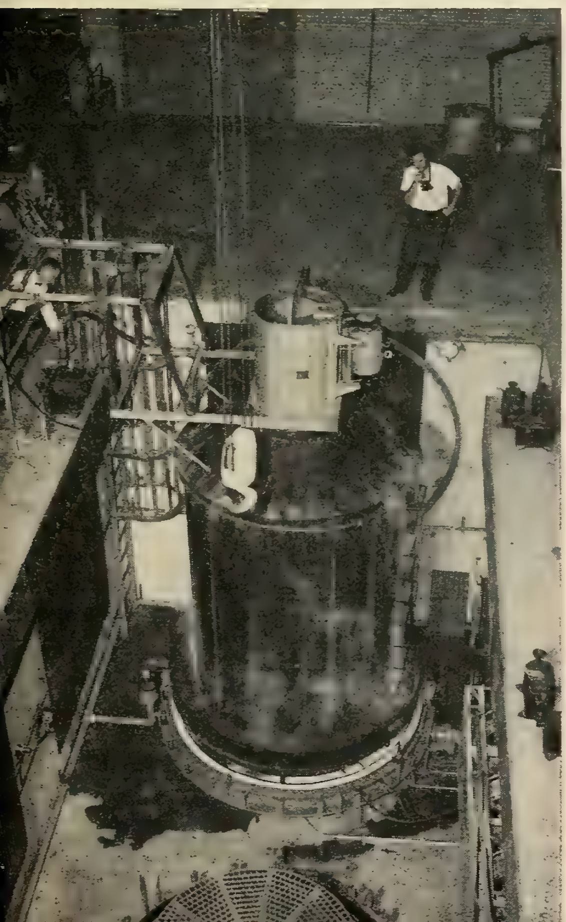
Reason for the bonanza in benefits is the new **General Electric** hydrogen bell brazing furnace installed at Aerojet's Sacramento plants. Applicable to other rocket engine fabrication processes, the method involves brazing in a sealed retort, over which a "bell" containing heating elements is lowered.

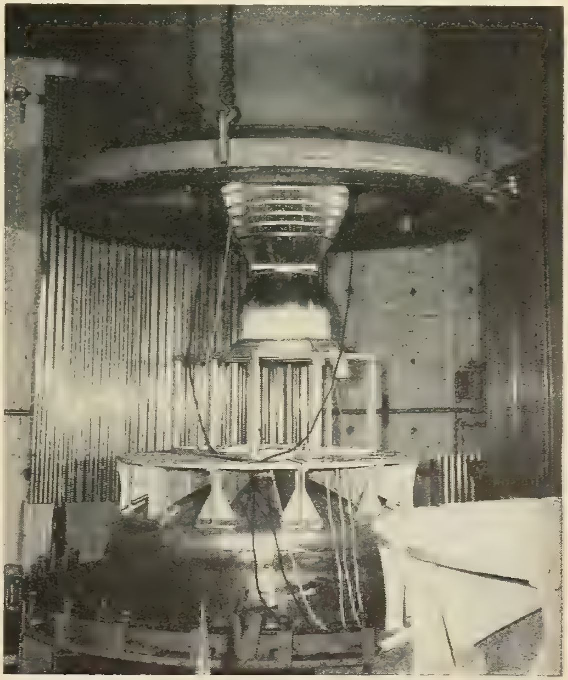
During the brazing cycle, the work within the retort is surrounded by a pure, dry hydrogen atmosphere, while the area between the retort and the furnace bell is filled with exothermic or hydrogen gas. The gas in the furnace bell protects the heating elements, which will corrode if exposed to air when heated.

• **Two gas sources**—Atmosphere for the two sections of the complex is provided by a pair of integral exothermic gas producers. One, a rich producer, provides combustible gas for heating element protection; the other, a lean producer, provides inert purging gas.

A "Deoxo unit" combines any free oxygen which might be in the hydrogen gas with hydrogen to produce a "wet" hydrogen gas, subsequently processed through a dryer to remove moisture.

The retort used in the furnace is a dome-topped cylinder with an open flared conical base. Retorts were originally of mild steel, which subsequently





COOLING HOOD in position over a hot thrust chamber. Its fan system circulates room-temperature air over the retort while a water spray in turn cools the hood itself.

RETORT BELL being removed from the work base after completion of the brazing cycle. Present retorts are made of thinly corrugated Inconel, which averts distortion.
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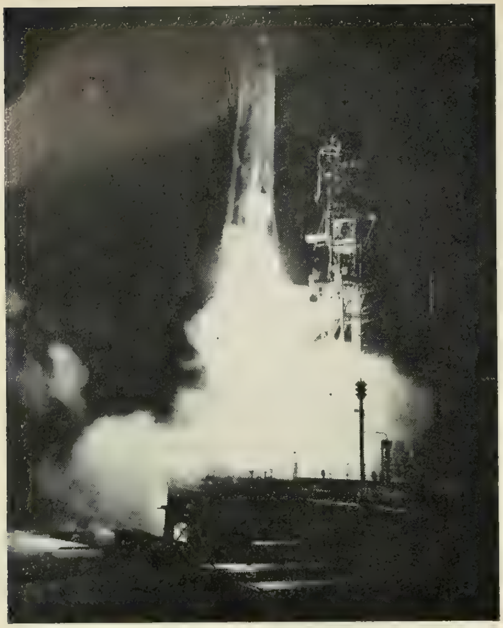
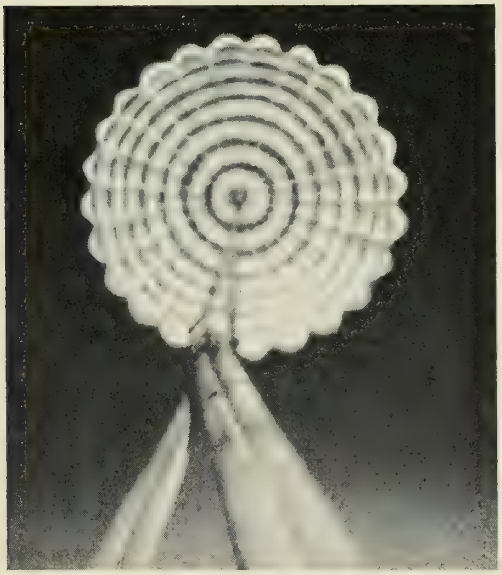


THE ATLAS MISSILE LAUNCHED NASA'S one-ton instrumented capsule similar to the one that will carry a man into space orbit. Initial landing phase began at 45,000 feet when a barometric switch fired a charge which deployed a Radioplane stabilization parachute directly aft into the airstream. At the same time, radar chaff was ejected to scatter into a 600-square-foot pattern to provide for radar locating and tracking.



AT 10,000 FEET another barometric switch initiated release of the stabilization 'chute and deployment of the 63-foot Radioplane Ringsail landing 'chute to safely lower "Big Joe" in its 30-feet-per-second descent. Upon water contact, a pyrotechnic charge released the Ringsail. Recovery was completed when a U.S. Navy destroyer, guided to the capsule by radar, lifted the undamaged "Big Joe" space capsule from the Atlantic.

NEWS IS HAPPENING AT NORTHROP

AFTER SPACE FLIGHT RADIOPLANE'S RINGSAIL BRINGS "BIG JOE"–NASA'S ONE-TON CAPSULE–TO SAFE LANDING

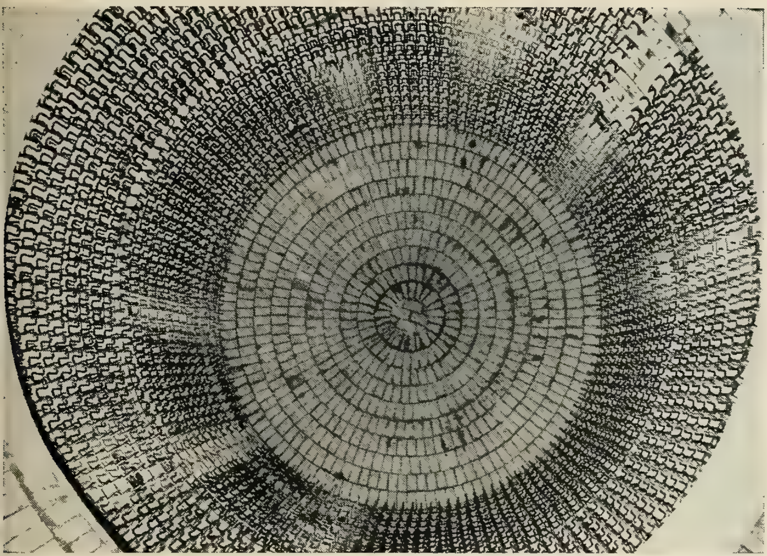
Recently the Space Task Group of the National Aeronautics and Space Administration sent its "Big Joe" capsule into space and successfully recovered it hundreds of miles down-range from Cape Canaveral. The landing system included a 6-foot conical ribbon stabilization parachute and a 63-foot landing parachute, the Ringsail. Both 'chutes, supplied by Radioplane, are proof of new advances in paradynamics.

Radioplane, also chosen by McDonnell Aircraft Corporation to develop and supply the landing system for NASA's Project Mercury, salutes its associates on this achievement. The success of this demonstration shows the ability to bring a man home safely after orbital flight.

RADIOPLANE

A Division of **NORTHROP CORPORATION**

Van Nuys, California, and El Paso, Texas



INSIDE OF the 1950°F, 12-ton heating bell of Aerojet's hydrogen brazing furnace, showing its 22 rows of heating elements. The process greatly speeds production.

proved vulnerable to distortion and scale after exposure to high temperature and air. Present models use thin corrugated inconel retorts, which do not distort appreciably or scale under similar conditions. Inconel also yields weight and heat-transfer advantages.

Furnace heating elements consist of ¼-in. keep in rod-type units capable of maintaining high temperatures. Molybdenum's characteristic offering of greater electrical resistance when heated requires that a variable power input control be provided. This is supplied to the furnace by a saturable reactor and proportional control, which offsets the resistance variant and provides for smooth, accurate control through both heating and operating phases.

• **Stress on safety**—Elaborate safety and warning equipment has been installed to protect operating personnel and prevent furnace damage. Gas flow or electrical power interruptions, for example, are signalled by both auditory and visual mechanisms which also indicate the trouble source. A flashing light remains operative until repairs are made or the power supply resumed.

To decrease explosion possibilities, numerous interlocks are built into the furnace complex. Another safety feature is an intercom system connecting all operators on the furnace equipment.

The *Titan* engine is a regeneratively-cooled type, the thrust chamber being composed of hundreds of thin-walled stainless steel tubes grouped and brazed to form a cone-shaped wall. Manifolds are then welded to each end of the cone to complete the chamber assembly.

In operation, rocket fuel enters the head manifold, is directed downward through alternate tubes, enters the other manifold, and is routed back through the remaining half of the tubing up to the head manifold, where it is ejected into the combustion chamber and ignited. The system serves the dual purpose of preheating the rocket fuel before ignition, and of cooling the thrust chamber tube walls.

Since heat transfer in such a system is extremely critical, Aerojet found it imperative that the brazing alloy used with the chambers during fabrication be applied evenly to avoid buildups which might cause hot spots and result in tube failure and eventual explosion.

• **How time is saved**—Previous to the use of the hydrogen bell furnace, fabrication was a combination of hand-welding and brazing involving over 100 hours of brazing and 35 hours of welding. Combining these operations in the new bell furnace, the company estimates production time at eight hours. (This is not man hours, since a three-man team will be required for furnace operation and subsequent minor hand-weld operations.)

Cycling of the engine with the new process will consist of a six-hour furnace cycle, followed by some hand-welding which cannot be accomplished in the furnace. Prior to the actual brazing operation, the thrust chamber components (tubing, manifolds, etc.) are assembled and held together by several tack welds and simple clamps. "Nicro-Braz" brazing alloy is then positioned on the assembled unit, and the chamber is ready for the furnace.

Brazing begins when the prepared assembly is positioned on one of two bases. These contain water-cooled, rubber-base seals and are designed to withstand high temperatures. Thermocouples are located throughout the assembly connected to multipoint strip chart recorders which record time and temperature conditions during the operation.

• **Special crane**—With the assembly in position, the retort is lifted and lowered over the assembly by a specially-built gantry crane. After being locked into position, a vacuum is drawn within the retort. When evacuation is complete, pure dry pressurized hydrogen is admitted to the retort.

The heating bell is then lowered over the retort and connected. The bell is already heated and contains an atmosphere of rich exothermic or hydrogen gas which is maintained well above the auto-ignition temperature of the gas. Final step is bringing the furnace to the melting temperature of the "nicro-braz" alloy. Hydrogen is fed into the retort during this period.

Following brazing, the hot furnace bell is lifted from the retort and replaced with a cooling hood. This hood is designed to prevent excessive heat radiation into the heat-treat room, and also to accelerate cooling of the part. A fan system circulates room air over the glowing retort while a water spray is directed over the hood.

When the retort has cooled sufficiently, the cooling hood is removed and the retort purged with inert gas. A vacuum is then drawn and held until the retort clamps are loosened. Removal of the retort and assembly completes the cycle.

Swedes To Buy *Seacats*

STOCKHOLM—The Royal Swedish Navy will use Britain's *Seacat* surface-to-air missile on its new "Östergötland" class destroyers.

The contract with the British firm of **Short Brothers and Harland Ltd.** calls for delivery in 1961 and includes spare parts, electronic equipment and a number of training and trial missiles.

The solid-propelled *Seacat*, slated for operational use with the British Navy, is radio-guided and fired from a radar-guided quadruple arrangement which includes parts of the current AA installations on board the destroyers.

This aspect reduces the cost of installation and, in addition, permits the use of the present fire control systems in *Seacat* launchings.

Sputnik III Results

A recent paper by V. G. Istomin gives details of information about the ionic composition of the upper atmosphere obtained from *Sputnik III's* instruments. (*Doklady Akademii nauk USSR,* Vol. 129, No. 1, 1959, pp. 81-84).

During the period May 15-25, 1958, 15,000 spectra of positive ion masses in the ionosphere were obtained by *Sputnik III* at altitudes of 225 km and 980 km by means of radio-frequency mass-spectrometer. Measurements were made between 27° and 65° N. latitude. The spectrometer had a negative charge gained from the gasmass through which the satellite moved, increasing the sensitivity of the instrument.

The spectra were found to contain harmonic peaks among the primary ones, the intervals for which had been predetermined in the laboratory. The most pronounced peak relates to mass number 16, attributed to atomic oxygen O^+; the second: 14, attributed to atomic nitrogen N^+.

Istomin reports that spectra obtained at the perigee showed a group of peaks with mass numbers 32, 30, and 28. The most pronounced peak relates to mass number 30, such as in ions of nitric oxide NO^+. Mass numbers 32 and 28 can be attributed to ions of molecular oxygen O_2^+ and molecular nitrogen N_2^+, respectively.

The ratio of atomic nitrogen to atomic oxygen varies depending on the geographic latitude and the distance from earth. The distance from earth's surface was divided into intervals, the first interval being from 225 km to 250 km, and the second from 251 km to 350 km. In both intervals, the concentration of atomic nitrogen increases upon transition from the zone 30°N-50°N to the zone 55°N-65°N. The influence of latitude vanishes at distances from earth greater than 450 km.

In general, *Sputnik III* indicated that the concentration of ions of nitric oxide, molecular oxygen, and molecular nitrogen increases at higher latitudes as compared to the concentration of ions of atomic oxygen. Ions of nitric oxide were found up to a height of 400 km; molecular ions were not found beyond 500 km.

Neutron Radiation Detector

A simple neutron radiation detector capable of operating in the presence of a strong X-ray field has been invented by two Russian scientists, according to a recent report.

The detector consists of two chro-

el-copel thermocouples of opposite plarities connected in a series circuit. he thermocouple joints are made of eel tubes, one filled with U_3O_8 enched with 75% U^{235}, and the other ith Pb_3O_4 (approximately 50 mg in ch tube).

The differential thermoelectromove force in the series circuit is proortional to the heating of the thermoouple as a result of U^{235} fision. This etection system was tested in neutron uxes from 5 x 10^8 to 1.5 x 10^{13}-/cm²sec with satisfactory results, ccording to the paper (*Pribory i tekhika eksperimenta,* No. 5, 1959, pp. 21-122).

oviet-French Exchange

The journal *Komsomol 'skaya pravva* reports that the USSR has concluded pact for exchange of information on ultural, scientific and technological atters with France. No specific deils have been released. (Dec. 13, 959, p. 4, col. 3.)

—when and where—

JANUARY

merican Astronautical Society, Sixth Annual Meeting, Statler-Hilton Hotel, New York City, Jan. 18-21.

merican Management Association, Special Research and Development Conference, Roosevelt Hotel, New York, Jan. 20-22.

tructure of Strong Normal Shockwaves, Northwestern University, Evanston, Ill., Jan. 21.

nstitute of the Aeronautical Sciences, 28th Annual Meeting, Hotel Astor, New York City, Jan. 25-28.

econd Annual Symposium on High Speed Testing, sponsored by Plas-Tech Equipment Corp., Somerset Hotel, Boston, Jan. 27.

esearch in Rarified Gas Dynamics, Northwestern University, Jan. 28.

eventh Annual Western Spectroscopy Conference, Asilomar, Pacific Grove, Calif., Jan. 28-29.

merican Rocket Society, Solid Propellants Conference, Princeton University, Princeton, N.J., Jan. 28-29.

FEBRUARY

hemical Institute of Canada, Toronto Section, Symposium on Gas Chromatography, Seaway Hotel, Toronto, Feb. 1.

nstrument Society of America, Houston Section, Instrument-Automation Conference & Exhibit, Rice Hotel & Sam Houston Coliseum, Houston, Feb. 1-4.

ixth Annual Midwest Welding Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology; Chicago Section, American Welding Society, Illinois Tech. Chemistry Bldg., Chicago, Feb. 3-4.

Tap Cartridge Eliminates Chipping

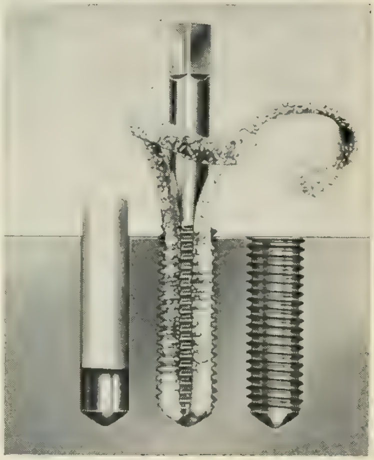
The Tap Cartridge Co. announces development of a new-formula wax pellet tap cartridge that completely eliminates the many chip problems encountered in blind hole tapping operations.

In the tapping operation, the tap cartridge is dropped into the already drilled, or drilled and reamed hole. As the tap works its way into the hole, a solid flow of wax carries the chips along and out the flutes as fast as the chips are made.

The last chips left at the bottom of the hole are embedded in that portion of the tap cartridge still in the flutes of the tap. Immobilized in this manner, they are withdrawn with the tap. The tap actually touches the bottom of the hole with no chip interference and there is no necessity to clean the tap between holes.

The new tap cartridge eliminates costly extra chip removal operations, reduces rejects due to torn threads, and over-comes tapered or oversized threaded hole. Tap breakage is also minimized because there are no chips to become wedged in the relief of the tap as it is being withdrawn.

Tap cartridges also allow tapping



in the bottom of the hole in one pass, produce a smoother, more uniform thread, and greatly extend tap life. Tap cartridges are available in sizes 0-80 through 1¼". They can be used equally well in steel, iron, aluminum, plastics, and the newer exotic metals.

Circle No. 225 on Subscriber Service Card.

Gas Generator Used For *Mercury's* Parachute

McCormick Selph Associates' SK-6119-26 and SK-6119-36 gas generators play an important role in NASA's plan for the landing phase of the Project Mercury capsule.

The generators provide the energy to eject the main and reserve parachute packs from their compartments. To assist in the ejection of the main parachute, an SK-6119-26 gas generator delivers hot gas pressure at 25 to 30 psi to the ejector bag.

As the bag inflates (in 1½ to 2½ seconds), it helps force the pack from the compartment. In the event that the reserve parachute is required, an SK-6119-36 gas generator is actuated to help eject the reserve pack. This generator also provides pressure to expel the reserve pack after landing should the reserve pack not be employed. This latter operation is necessary to clear an opening for the astronaut's exit.

Each gas generator consists of an igniter; a one-piece screw-in type nozzle; a vibration-dampened solid propellant grain and a stainless steel gas delivery and heat exchanger tube.

After ignition, the gas pressure generated is routed through a stainless steel tube which drops the heated gas from 3000°F. to 740°F. as it enters the inflation bag. This nylon bag, 11 inches in diameter and 31 inches long, is covered with latex .007 inches in thickness. The SK-6119-26 gas generator is a zero time delay unit and the SK-6119-36 is a 1.25 second time delay unit. The gas generators provide pressure to inflate each bag completely in less than three seconds and force the ejection of the chutes with maximum clearance and safety.

Circle No. 226 on Subscriber Service Card.

Pressurized Machine Spins Solids at Huge G-force

A pressurized machine that twirls solid particles during chemical processing at a g-force 40 times greater than that experienced by an astronaut in space flight has been developed by the Chemical Machinery Division of **Baker Perkins Inc.**

It is built to remove from a liquid carrier solids like those of polyolefins, vinyl resins, penicillin, corn starch titanium, aspirin and acrylic resin fo carpets by centrifugal action at a forc of 1000 g.

Before being placed in operation materials in the machine's 40-in "basket" are pressurized under 150 psi and while under that pressure, sub jected to a centrifugal force of 1000 —as they are rotated at 154 miles pe hour. Production capacity of the ma chine is reported to be 30 tons pe hour.

Circle No. 227 on Subscriber Service Card.

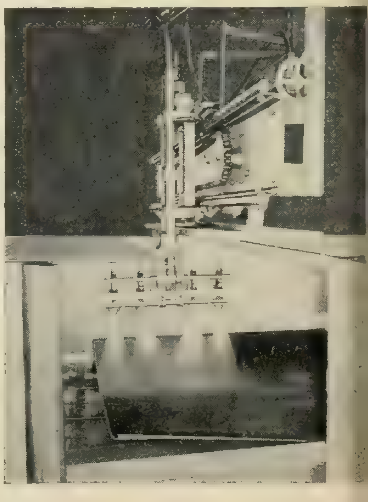
Adhesive Developed for Automatic Spray Applicatior

A 3M high-strength-oil-resistant elas tomeric base adhesive developed fo automatic spray applications in volume production operations and for bonding a wide variety of porous and non-por ous materials is now available from the Adhesives, Coatings and Sealers Divis ion of the **Minnesota Mining and Mfg Co.**

Bonds produced by this general pur pose industrial adhesive, designated a EC-1390, have high softening point and good resistance to plastic flow These properties, combined with the adhesive's rapid rate of strength build up and good sprayability, makes it wel suited for volume production applica tions. This adhesive may also be hand sprayed or brushed.

The adhesive produces high strength laminates with such materials as plastic thin gauge aluminum and steel, porce lain enameled steel, linoleum, leather rubber, wood, composition board and other materials.

Typical uses are: Bonding alumi



um facings to paper honeycomb cores sandwich panel contruction. Wood-steel bonds have shear strengths in e range of 400 psi.

High pressure plastic laminate-to-eel bonds have tensile-shear strengths f 400 psi and peel strengths averaging 0 pounds per inch width.

Circle No. 228 on Subscriber Service Card.

-Digit Resolution Voltmeter roduced at Lower Cost

A low-cost digital voltmeter with ll four-digit resolution has been an-ounced by **Non-Linear Systems, Inc.**

The V64, which costs only $785, designed for a wide range of DC easuring jobs and, with accessories, C and low-level DC measurements. he V64 features full four-digit 0.01%) resolution, high input im-

edance and an average measuring ime of 0.27 seconds per reading.

A one-package instrument, the V64 s 5¼ inches high by 15¼ inches deep or mounting in a standard 19-inch rack.

Circle No. 229 on Subscriber Service Card.

High Power Gridded TW Tube Developed

A one-kilowatt traveling wave tube ombining a periodic focused perma-ent magnet (PPM) with a gridded gun s being produced by **Hughes Aircraft Company.**

The tube, which operates in the S-and from 2.0 to 4.0 kmc, is said to e particularily useful to radar systems uilders and users.

Combination of permanent magnet ocusing with a gridded gun produces traveling wave amplifier which Hughes Aircraft claims exhibits full one-kilo-watt power output characteristics with ow power consumption.

Previous to the development of the ew Hughes tube, traveling wave tubes with magnetic focusing used a pulsed cathode to supply the beam and in-volved pulse levels of 5,000-10,000 volts resulting in a difficult modulation problem, according to Richardson.

Use of a control grid, however, en-ables the Hughes tube to operate with a very fast response time with much lower power consumption and simpler modulation problems.

Traveling wave tubes with gridded

guns at this power level have been available but only with solenoid focus-ing. Permanent magnet focusing offers the advantage of light weight, no solen-oid power supply needed, low heat gen-eration and better reliability.

Known as the Hughes MAS-1E traveling wave amplifier, the new tube is the result of solution of certain tech-nical problems by the company's re-search and development laboratories.

One of its primary uses is as a final output tube. If still more power is re-quired it can be used to drive other high powered traveling wave tubes or klystrons. Its peak output is in excess of 1 KW at only 0.5 W input. By cas-cading two tubes an output of 1 KW can be obtained with less than 0.5 W of drive.

Circle No. 230 on Subscriber Service Card.

Dielectric Coolant Pump Aids Cavitation Problem

A new high efficiency, lightweight pump designed for liquid cooling of electronic instrumentation and able to pump any dielectric fluid has been mar-keted by the **Task Corp.**

According to the manufacturer, the new dielectric coolant pump is de-signed to minimize cavitation problems encountered with low inlet suction pres-sures of high-altitude operation. Unique wet motor construction obviates use of rotating seals and attendant leakage problems.

Other applications include use as fuel transfer or booster fuel pump; the unit can be manufactured to meet ap-plicable military specifications.

Specifications include: continuous duty 4 pole, 3 phase, 200 volt motor; weight, 21 ounces; amps, 0.75; pump pressure rise, 20 psi at 2.8 GPM. The pump is 4.38 inches long and has a diameter of 2 inches. Bearings are car-bon and the pump can run dry.

Circle No. 231 on Subscriber Service Card.

Lightweight Adjustable Regulating Valve Available

A new pressure regulating valve in-troduced by Vap-Air, the aeronautical division of **Vapor Heating Corp.,** fea-tures light weight, small size, low leak-age and stability of control.

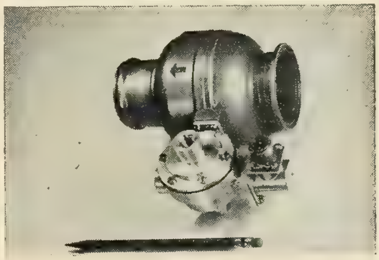
The valve, suitable for dozens of missile applications, weighs 2.6 pounds, handles upstream pressures to 200 psi with variable downstream regulation from 5 to 25 psi. (specifications cited refer to the 2 inch diameter valve handling air at 80°F.)

Leakage is low since it has a pos-itive metal to metal seat rather than a butterfly with "0" ring seals. Leak-age is from 0.005 lbs./min. at 25 psi inlet pressure to 0.014 lbs./min. at 200 psi inlet pressure.

The outlet pressure reaches its regulated level within ½ second. A typical example: With inlet air pres-sure going from 0 to 80 psi in two seconds, downstream regulated air pressure goes to 10 psi (regulated point) in ½ second.

Pressure drop through the regulat-ing valve at 10 lbs./min. air flow is 1.4" Hg; at 25 lbs./min. air flow, drop is 6.2" Hg.

Typical stability of control at an arbitrary 12 psi setting shows a maxi-



mum pressure variation on the outlet side of the valve from low of 11 psi to high of 12.5 psi, with inlet pressure varying from 0 to 200 psi.

The Vap-Air pressure regulating valve is made of stainless steel or monel, or other metals to suit the customer's needs, handles air at up to 625°F.

A remote controller weighing 0.4 lbs. permits variations in pressure regu-lation from 5 to 25 psi. In a typical installation, this controller is mounted on the pilot's console.

The valve body overall diameter is 3.62", length 4.19".

Circle No. 232 on Subscriber Service Card.

New Fluid Curbs Heat-Treat Carbonization

A new carbon potential liquid, de-veloped after two years of laboratory work by **A. F. Holden Co.,** now enables heat-treat engineers to take preventive measures against decarburization and scale formation on carbon steels to meet rigidly prescribed physical standards.

Designed primarily for use with the luminous wall, gas-fired furnace, it is

automatically injected under pressure during the high heat phase. The fluid supplies a supporting atmosphere which burns up excess oxygen and brings the products of combustion to a balanced state.

Coordinated with the furnace operation, decarburization and scale are controlled, reduced to a minimum. Amount of liquid injected is governed by the size and BTU rating of the furnace in use. Because the luminous wall is an open combustion system, it is possible to introduce the liquid to provide a non-explosive atmosphere.

Several grades have already been made available; others are in various stages of development. The fluid is used in the processing of steels ranging in carbon content from 0.20 to 1.00. Each can be applied to a specific type of steel of given carbon content for any heating cycle.

To accurately pinpoint the required treatment, Holden engineers report a laboratory test of customer steel samples is sometimes necessary to determine the proper carbon potential grade for the job.

Circle No. 233 on Subscriber Service Card.

Silicon Computer Diodes Claimed to be Fastest Yet

High-voltage silicon mesa diodes—claimed to be the industry's fastest—are available from **Texas Instruments, Inc.**

The diffused devices switch from 10 ma forward current to six volts reverse in four millimicroseconds maximum.

The fast switching capability of the TI 1N914 and TI 1N916 diodes is coupled with an extremely low capacitance of only two micromicrofarads (max), making them especially desirable for high-frequency applications. For frequencies up to 100 megacycles, both diodes provide a minimum rectification efficiency of 45% and have a guaranteed maximum leakage of 25 millimicroamperes at 20 volts.

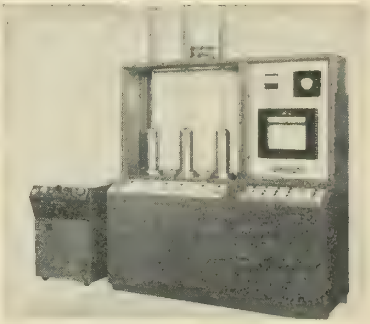
Packaged in a subminiature, hard glass package, the diodes feature a high peak inverse voltage of 75 volts. Both devices will dissipate 250 mw of power at 25°C and highlight a guaranteed minimum forward voltage of 1 volt at 10 milliamps. Through the use of silicon mesa construction, both diodes have an operating range of −65 to 150°C and a maximum storage temperature of 200°C.

The units will withstand 20,000 g during acceleration and 1000 g during shock. The black epon paint used on the TI glass packages withstands moisture, salt spray and 200°C storage temperatures.

Circle No. 234 on Subscriber Service Card.

Leak Detection System Minimizes Operator Error

General Vacuum Corp. has announced a "Series 800" line of high-production Leak Detection Systems designed specifically for in-line operation and high production rates. The systems are either fully or semi-automatic eliminating or minimizing operator error.



Results are quantitative so that changes in quality may be detected, recorded, and action taken prior to rejection on a "go-no-go" basis. The results are also reproduceable since the process takes place in a controlled vacuum and is not affected by stray gases or other variables in the atmosphere.

The Series 800 Leak Detection Systems are suited for production testing of all types of vacuum, pressurized, and hermetically sealed products such as aerosols, gas cylinders, refrigeration and air conditioning systems, radiators, missile and aircraft components, electronic assemblies, and fire extinguishers.

The Series 800 incorporates a standard mass spectrometer type leak detector sensitive to helium gas which can also probe rejected items to determine the exact location of the leak.

Circle No. 235 on Subscriber Service Card.

NEW LITERATURE

CHEMICAL MILLING. A 12-page illustrated booklet describing the process of chemical milling and the function of the **Chemical Contour Corp.,** is available free of charge. Chemical Contour Corp., 16627 South Avalon Boulevard, Gardena, California.

Circle No. 200 on Subscriber Service Card.

SPACE CHAMBERS. A brochure describing features and capabilities of walk-in space chambers and picturing many applications is available from **Tenny Engineering, Inc.,** a producer of environmental test units. The huge chambers include a variety of specifications for the simulation of extreme conditions, such as altitudes to 1.5 million feet, temperature from −150° to +2000°F., humidity to 95% rain fall to 24 inches per hour, ram air flow, varied altitude climb and dive rates, solar radiation to 140 watts per square foot, radiant heat assemblies, dissipation of live or static loads and vibration accommodation.

Circle No. 201 on Subscriber Service Card.

DIMENSIONING. An illustrated 28-page booklet presenting a step-by-step explanation of the theories and practical application of the system of True Position Dimensioning. It reflects **Scintilla Div. of Bendix Aviation's** experience gained in over four years of actual application of this dimensioning practice in manufacturing for the military.

Circle No. 202 on Subscriber Service Card.

METAL CRYSTALS. An eleven-page Bulletin No. 102 entitled "Large Single Metal Crystals," which describes standard specimens as well as unusual shapes and special crystal orientations, is available from **Flow Corporation.** A large number of randomly oriented single metal crystal specimens in aluminum, cadmium, copper, lead, nickel, silver, tin and zinc are now available for immediate delivery in many standard sizes and shapes.

Circle No. 203 on Subscriber Service Card.

CORROSION. A new bulletin describing and illustrating results of a U.S. Signal Corp's Mirror Test for corrosiveness of printed circuit resin fluxes is now available from the **London Chemical Co.** The test was run in accordance with MIL F-14256 by the Inland Testing Division of **Cook Research.** Seven fluxes were tested, some at 50% solids, others "as is." Four of the fluxes, including a W. W.-cg-rosin used as a control, passed the test by showing little or no corrosive action on copper and proving superior solderability.

Circle No. 204 on Subscriber Service Card.

NAVY

,337,225—**Motorola, Inc., Military Electronics Center**, for sonobuoys.

0,500—**Reading Products Co., Inc.**, Boyertown, Pa., for inert parts for 0.7ES target drone boosters.

2,296—**Giller Tool Corp.**, Dallas, for guided missile tool kit, mechanical assembler.

MISCELLANEOUS

'estern Scientific Instrument Co., Inc., has received a contract from **Hughes Products Group**, subsidiary of **Hughes Aircraft Co.**, for continued maintenance of vital laboratory production test equipment.

,000,000—**Iron Fireman Manufacturing Co.**, Electronics Div., for delivery of gyroscopes for the Radioplane Div. of **Northrop Corp.**

215,000—**Oliver-Shepherd Industries**, Nutley, N.J., for design and manufacture of digital and analog airborne magnetic tape recorders. Awarded by **Airborne Instruments Laboratory**, a division of **Cutler-Hammer, Inc.**

AIR FORCE

5,244,096—**Raytheon Co.**, Microwave-Power Tube Div., Waltham, Mass., for magnetron electron tubes. (Two contracts.)

2,000,000—**Perkin-Elmer Corp.**, Electro-Optical Div., Norwalk, Conn., for production of alignment theodolites for the *TM-76B* missile. Sub-contract from **AC Spark Plug Div. of General Motors.**

164,999—**Divco-Wayne Electronics**, Cincinnati, for spare parts for radar test set.

98,957—**Cornell Aeronautical Laboratory, Inc.**, Buffalo, for research on "Molecular Interactions at High Temperature."

53,766—**Syracuse University**, for research in "Quantum Field Theory and Elementary Particles Studies."

52,120—**Cornell Aeronautical Laboratory**, for research on "Nonequilibrium Flows."

49,958—**Massachusetts Institute of Technology**, Cambridge, for research on "Mechanical Behavior of Metal Composites."

48,576—**Cornell Aeronautical Laboratory, Inc.**, for research on "Boundary Layers in High Temperature Gas Flows."

33,980—**University of Pennsylvania**, Philadelphia, for research on "Scattering and Polarization of Electrons" and "Factors of the Free Electrons."

ARMY

'ook Electric Co. has received a contract for theoretical design of the data system for the White Sands **ARTRAC** plan. Amount not disclosed.

6,708,846—**Land Air, Inc.**, Chicago, for research and development data collection and research and development services of range instrumentation equipment at White Sands.

3,065,000—**CompuDyne Corp.**, Hatboro, Pa., for ground support equipment for use in six *Titan* ICBM operational bases.

2,084,220—**Telecomputing Service, Inc.**, for research and development data evaluation at White Sands Missile Range.

1,136,771—**Brown Engineering Co.**, Huntsville, Ala., for engineering and machine shop services on missiles.

900,000—**International Telephone & Telegraph Corp.**, Federal Division, Clifton, N.J., for repair parts for radar target simulator.

231,281—**Brown Engineering Co.**, Huntsville, Ala., for engineering and design for Ordnance Missile Laboratories Div., **ARGMA.**

$179,043—**Fairchild Camera and Instrument Corp.**, Syosset, N.Y., for 216 fuze rocket, mechanical time, T2075, loaded.

$175,265—**Allied Chemical Corp.**, General Chemical Div., N.Y., for guided missile nitric acid propellant. (Two contracts.)

$174,500—**Western Electric Co., Inc.**, New York City, for *Nike* spare parts and components.

$173,000—**A. P. Whitaker & Sons**, Randolph, Mass., for construction of FD radar facilities.

$158,000—**Brown Engineering Co., Inc.**, Huntsville, Ala., for engineering and machine shop services.

$135,000—**California Institute of Technology**, Pasadena, for research and development of guided missiles.

$125,336—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering services.

$120,168—**Norris-Thermador Corp.**, Vernon, Calif., for motors for 115mm boosted rocket.

$98,750—**Lavoie Laboratories, Inc.**, Morganville, N.J., for oscilloscope.

$75,000—**Sperry Rand Corp.**, Sperry Utah Engineering Laboratory, for repair parts for *Sergeant* guided missile systems.

$59,467—**General Development Corp.**, Elkton, Md., for development of ballistic measurement equipment.

$27,991—**Southern Research Institute**, Birmingham, Ala., for engineering and technical services on new heat polymers.

$17,850—**Rentel & Frost, Inc.**, Boston, for construction of aircraft weapons calibration facility.

Physicist Doubts Red Data On Moon Magnetism

PASADENA, CALIF.—A paper by a physicist at the **Jet Propulsion Laboratory** states that *Lunik II* data used by Soviet scientists to prove the moon has no magnetic field is not conclusive.

Mrs. Marcia Neugebauer of JPL points out that the Soviet satellite took its measurements on the sun side of the moon, where incoming corpuscular radiation would interact with the weak magnetic field and tend to cancel it out.

Mrs. Neugebauer points out that the Soviet magnetometer was capable of detecting fields down to .0006 gauss and that the final reading before impact presumably was obtained at a lunar altitude of one kilometer.

"It is suggested that, if a general lunar magentic field existed, it would be confined by solar corpuscular radiation, or solar wind, to a thin layer above the sunlit surface, but it could extend a considerable distance beyond the surface on the side away from the sun," Mrs. Neugebauer declares.

Machining Process Acquired

WINDSOR LOCKS, CONN.—Hamilton Standard Division, **United Aircraft Corp.,** has acquired North American rights to an electron beam process developed by the **Carl Zeiss Foundation** of West Germany for machining or welding the hardest materials.

The process operates in a high vacuum (4 x 10^{-6} mm Hg), developing a precisely controlled beam of high energy density that can be directed to do work on a target.

Charles M. Kearns, general manager of Hamilton Standard, said the process is valuable in manufacturing parts for electronics, missiles and aircraft, nuclear power equipment and many other industrial areas, as well as research laboratories.

Although other electron beam equipment is being manufactured in this country, Kearns said, none has reached the stage of development attained by the Zeiss process in controlled energy densities.

The Zeiss electron beam can raise a target point to 11,000°F, while the temperature registered a micron (.000039") away is only 550°F. It can weld, melt or cut holes as small as .0008" through almost every known material—including tungsten and the refractory metals.

Energy density during drilling may be as high as 600 million watts per square inch. Hamilton Standard said even higher energy density and much smaller holes and slots are contemplated in the near future.

In laboratory tests by the Zeiss Foundation in Oberkochen, West Germany, the equpiment has welded through stainless steel 1" thick in a few seconds. In production applications, it has welded through stainless steel ½" thick.

Hamilton Standard said the process has demonstrated major improvements in the welding of reactor cores for nuclear energy installations and the milling of sub-miniaturized electronic components.

The process may be controlled by electrical relays or by complete electrical and mechanical automation.

Headquarters NASA Groups Are Renamed

WASHINGTON—NASA last week renamed two of its three original headquarters organizations to conform with their new duties.

Renamed were the Office of Advanced Research Programs (formerly the Office of Aeronautical and Space Research) under the direction of Ira H. Abbott, and the Office of Space Flight Programs (formerly the Office of Space Flight Development), under the direction of Dr. Abe Silverstein.

The action was taken because of the recent creation of a NASA Office of Launch Vehicle Programs under the direction of AF Gen. Don R. Ostrander. (See M/R, Dec. 14, p. 40). The new office was carved out of the two existing offices, and their names were changed accordingly.

The fourth NASA headquarters unit is the Office of Business Administration.

NASA Asks World's Help For Explorer IV

WASHINGTON—The National Aeronautics and Space Administration Dec. 30 released the radio codes for the seven different scientific experiments in *Explorer VII* and invited Soviet scientists and scientists from other countries to listen in and participate in analyzing the information.

Dr. Homer E. Newell Jr., NASA Assistant Director, said he hoped scientists from the Soviet Union, Japan, Red China, India, and Indonesia, and others in Asia, Africa, and the South Pacific would take part in the program.

One reason for releasing the codes, Dr. Newell reported, was that American scientists were hampered by "gaps" in the reporting of signals, and cooperation with foreign scientists could provide a world-wide reception system for the satellite's information.

M/R Contributor, Adviser Honored

TULSA, OKLA.—An adviser and a contributor to MISSILES AND ROCKETS MAGAZINE are among the "Ten Outstanding Young Men of 1959" chosen by the U.S. Chamber of Commerce.

They are Dr. S. Fred Singer, professor of physics at the University of Maryland, and Dr. Peter A. Castruccio, technical director, Aerospace Division, **Aeronca Manufacturing Corp.**

Dr. Singer, 35, was cited for his 1951 design of a small scientific earth satellite and for his leadership of the first group to measure the earth's magnetic field at 100 miles altitude. He is a frequent contributor to M/R and in 1958 wrote a series of four articles entitled "Nuclear Explosions in Outer Space," which drew wide acclaim.

Dr. Castruccio, 34, holds several radar patents and has numerous patents pending. He worked with **Bendix Radio** and the **Martin Co.** before joining Aeronca last summer. He is a member of the M/R Advisory Board.

Sperry Test Basin Devised for ASW

GREAT NECK, N.Y.—Effective evaluation of underwater detection devices without extended sea trials will soon be possible at **Sperry Gyroscope.**

A test basin, 400 ft. long, 200 ft. wide and 25 ft. deep, is being constructed by Sperry's Surface Armament Division. A 17 by 29 foot floating barge will be used to sink the sensing equipment under evaluation into the water.

Measuring facilities and equipment to simulate the desired sounds of subs, fish and other marine disturbances will be placed at the other end of the basin.

Not only sound devices such as SONAR but non-acoustic instruments for the location of anti-ship mines, torpedoes and submarines can be tested at the new basin.

The data supplied from the controlled experiments planned may lead to the development of equipment that will considerably extend the range and selectivity of present detection techniques and instruments, Sperry says.

Ryan Acquires Aerolab Development Co.

SAN DIEGO—**Ryan Aeronautical Company** has expanded its space capability by acquiring **Aerolab Development Company** of Pasadena.

Aerolab, now a wholly-owned Ryan subsidiary, has been active in the field of multistage high-altitude sounding rockets and rocket-fired free flight testing of dynamically similar models.

Ryan acquired both the majority Aerolab stock interest held by **U.S. Hoffman Machinery Corp.** of New York since 1955, and minority stock of Aerolab founder E. G. Crofut.

Aerolab will continue operations at Pasadena under direction of Ryan vice president E. G. Uhl, former **Martin Company** vice president who joined Ryan six months ago. Uhl was general manager of the Martin Division at Orlando, Fla.

Aerolab has specialized in arranging standard military rockets such as *Honest John, Nike, Sergeant, Recruit* and others into multistage combinations. Among Aerolab sounding rockets have been systems known as *Argo, Jason, Javelin, Journeyman* and *Percheron.*

Solar Radiation May Be Top Hazard

SANTA MONICA—The main radia-on danger in space travel is expected come not from the Van Allen belts it from the sun itself in the form of lar flares and corpuscular streams, cording to a study by three **Douglas ircraft Company** researchers.

They describe these solar emana-ons as the least understood and per-ps the most dangerous of space ra-ations.

"Solar flares are probably the most ngerous to man," the paper said. The nission of energetic protons during a re could result in dose rates as high 1000 Roentgen per hour in outer ace, it declared. The particles are be-ved to be in the hundreds of Mev nge, "occurring without warning and no particular pattern that can be de-rmined at this stage of our knowl-lge."

The study, prepared for publication the Institute of Aeronautical Sci-ces, was made by M. W. Hunter, as-stant chief engineer, space systems; E. Konecci, chief of life sciences, and F. Trapp, nuclear engineer.

In the corpuscular streams the dose rate may be higher than in solar flares, but the energies are lower, the Douglas scientists said. Shielding of space travelers against the streams therefore is expected to be simpler.

The paper also noted that streams are preceded by the more dangerous flare so that detection and protection against the flare will give warning against possible arrival of a stream.

"Usually, the flare activity follows very closely the sunspot activity," the paper said. "However, there have been many solar bursts of intense radiation which have occurred during minimum sunspot activity. Although some correlation exists between sunspot activity and solar flare frequency, no definite theory can be postulated until satellites have explored the flare phenomena during minimum sunspot numbers, i.e., approximately five years away."

Radiation environment in the Van Allen belts comes from high-energy protons, the study said, predicting that transit through the inner belt might yield a dose of 2-10 rem. High-energy particles could be stopped by material used for space vehicle structure or for sustenance, it was stated.

"In determining the radiation environment in detail," the Douglas scientists said," shield estimates will have to be examined in light of secondary radiations. Since unshielded radiation intensities in the inner belt may be as high as 100 rem/hr., man will most certainly require shielding while performing extravehicular functions."

The study said the outer Van Allen belt exhibits an equally dangerous unshielded environment from electron fluxes, but it noted that these radiations can be removed by modest shields.

The radiation study was made in connection with the hypothetical journey of a three-man expedition to Mars in a two-stage, 734,000-lb., nuclear-powered vehicle. The three scientists said the U.S. can undertake such an expedition within the next 10 years.

Radiation exposure on such a 421-day round trip, including that from the propulsion system, would be within permissible limits, the researchers said.

9.5 Billion Market een for Electronics in '59

LOS ANGELES—Profits for elec-onics manufacturers will become nar-wer despite an increased share of the efense dollar, according to a predic-on by Kenneth F. Julin, president of **each Corporation.**

In a year-end survey, Julin esti-ated the electronics industry will hit peak of $9.5 billion in military and mmercial production in 1960.

But he said mounting competition ill prevent price increases in spite of sing production costs. Higher cost of search and development is expected be another factor holding down ofits.

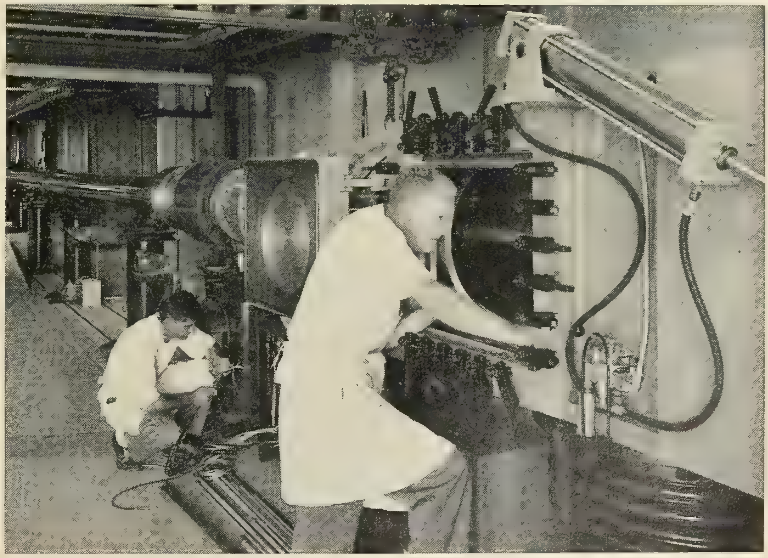
Julin said the struggle for survival the industry may last another five to ght years.

eramics Division lant Being Expanded

LOS ANGELES—**Gladding, McBean d Company,** producing ceramic nose nes for the *Sparrow III* guided mis-le, is expanding its newly formed chnical ceramics division.

The company has leased a 15,000-.-ft. plant in Monrovia which is ex-cted to be in operation by Feb. 1. he plant is described as a highly auto-ated production facility.

CAL Operating New Shock Tunnel



BUFFALO—**Cornell Aeronautical Laboratory, Inc.** has put on the line a new hypersonic shock tunnel for testing missile designs at speeds up to 14,-000 mph.

Small-scale prototype work has been performed for **North American Aviation, Boeing, McDonnell, Chance Vought** and the Air Force's Wright Air Development Center. A CAL innovation, "tailored interface," enables the tunnel to produce steady airflows for 15 milliseconds, about eight times longer than possible with previous shock tunnels.

Shock tube is 90 feet long and one foot in diameter. Nozzle and test section extend 20 feet beyond the tube.

west coast industry . . .

By FRANK G. McGUIRE

A ten-year "program of action" has been instituted by the Los Angeles Chamber of Commerce to combat various industry problems during the '60's. Chamber President J. E. Fishburn, Jr., commented that "serious economic problems are coming into focus just now for every business, and the opening of a new decade has a turning-point characteristic." The new program will deal with inflation, excess production costs (in which featherbedding is a prime target), surplus capacity, and other industry complaints.

The chamber foresees population increasing from the present 6.6 million in the metropolitan area to 9.3 million by 1970. The labor force is expected to increase from 2.7 million to 3.9 million in the same period. Further inflation is predicted, with the value of the 1947-49 dollar expected to drop from the present $.78 to $.62 by the end of the decade.

Networks Electronic Corp. . . .

has set up a fourth division, **Infrared Laboratories,** to develop such components as IR detectors, detector dewars, detector coolers, and low-noise preamplifiers. Subsequent plans call for the company to enter the prime contracting field in IR guidance systems. In the past two years, the firm has expanded from a one-product operation to one having a line of 55 miniaturized, proprietary products.

Electronic Engineering Co. of California . . .

has recently come up with two needed systems. One, a tape search and control system, will automatically play back a selected portion of tape on the **Ampex** FR-100, at a search speed of 120 ips. The other, a computer language translator, will greatly speed handling of *Hound Dog* test data.

North American Aviation, Inc. . . .

has paid its largest employe-suggestion award, $7275, to three technicians at Rocketdyne's propulsion field laboratory. The three photo lab employes developed a splicer for oscillograph record paper. Previously, much of the expensive paper was wasted on short runs. The new machine will eliminate much of this loss.

Aerojet was outbid in a land auction . . .

of surplus government property in Yuba County, Calif. AGC, which wanted to use the 40,585 acres for rocket engine testing, went as high as $45 an acre (a total of $1,826,325) but lost anyway. The land will probably be used for cattle raising.

Douglas' F. W. Conant . . .

feels the transition from aircraft to missiles is primarily an engineering transition, and will be performed most rapidly under pressure from a generation of engineers and scientists. The senior vice president of **Douglas Aircraft** suggests that the manufacturing transition is not as drastic as the engineering transition. Likening the situation to the change from sail to steam, he said he feels no fear for the future of Douglas in the Missile/Space Age.

United Research Corp. . . .

is rapidly "organizing and getting under way" in the industry, and expects to play a major role in the space effort. Two multimillion-dollar facilities are under initial construction, one in Sunnyvale and the other 13 miles southeast of San Jose. Reports indicate the firm will make a dramatic bid to demonstrate its capability in solid-propellant rocketry by developing, entirely with its own funds, a million-pound-thrust booster in a relatively short time.

Hewlett-Packard's new test instrumentation . . .

which is quite flexible because it's assembled from standard compatible components, has the name "MARTINI" hung on it. Seems the name stands for "Massive Analog Recording Technical Instrument for Nebulous Indications." A footnote at the bottom of the tech sheet says "Machine and operator require same before and after operation."

Alfred H. Faulkner: appointed technical director of Automation Industries, Inc.'s Datran division, responsible for all engineering and manufacturing activities.

FAULKNER

Faulkner was formerly senior staff engineer for Telemeter Magnetics, Inc. In previous ositions he developed a line of commerial electronic instruments and was superisor of electronic switching systems for utomatic Electric Co. He holds patents n twenty inventions and has thirty pendng.

Robert F. Goodwin: vice president, elected president of Airtek Dynamics, Inc., manufacturer of missile assemblies, ground support equipment and commercial marine hardware accessories, succeeding **Gustave G. Michel,** named chairman of the board.

GOODWIN

Goodwin joined Airtek in 1956 as vorks manager after previous experiences n executive and engineering positions vith General Metals Corp., George H. Elliott & Co., Martin Co. and Pratt & Vhitney division, United Aircraft Corp.

Philip S. Hessinger: named research manager for National Beryllia Corp. In the newly created position he will be associated with **Dr. Eugene Ryshkewich,** director of research, in the development of beryllium oxide and other pure metal oxide ceramics.

HESSINGER

Previous post: acting director, reearch and development for Mycalex Corp. of America; also engaged in and lirected ceramics research at Ohio State Jniversity Research Foundation and Vright Air Development Center.

T. W. Shinafelt: appointed to the newly-created position of director for quality control and service departments of the Aeronautics division of Chance Vought Aircraft, Inc.

SHINAFELT

Prior to joining Vought (1947), as assistant supervisor of engineering liaion, Shinafelt served with the Navy's Bureau of Aeronautics as project officer on several aircraft programs.

M. M. Siar, Jr., assistant service manager, will succeed Shinafelt as manager of the service department.

Frederick C. Durant, III: named director of public and government relations and **E. Douglas Kenna, Jr.,** director of marketing at Avco Corp.'s Research and Advanced Development Division.

Durant, who joined Avco in 1957 as executive assistant to the director of Avco-Everett Research Laboratory, was previously a staff member of Arthur D. Little, Inc. Kenna returns to Avco from Westinghouse Electric Corp., where he was product division manager.

Richard M. Clarke: elected sales manager of Joclin Manufacturing Co., designers and custom molders of high and low temperature reinforced plastics. Was previously in charge of product design and development.

Other appointments: **Kerin G. Boardman,** West Coast regional manager; **Arthur J. Goodwin,** representative for the New England States; **Stephen C. Markham** for Upper New York State and the Great Lakes Region; **Bedford Byron** for the Middle Atlantic States and Metropolitan New York.

Robert B. Corby: appointed staff engineer in the program planning department of Motorola, Inc.'s Western Military Electronics Center. Corby joined the company in 1953 as assistant manager in microwave products, was formerly marketing coordinator for the firm's military plants.

Efcon, Inc. names **Joseph Sipovic** project engineer of the film capacitor division and **Adolph Herbst** project engineer of the tantalum capacitor division.

Sipovic was formerly chief engineer with the condenser products division of New Haven Clock & Watch Co. Herbst was previously associated with Pyramid Electric Co. as chief field engineer and was responsible for the development of tantalum capacitors.

Dr. M. John Rice, Jr.: appointed manager of semiconductor material engineering at CBS Electronics, manufacturing division of Columbia Broadcasting System, Inc. Was formerly director of research for Trancoa Chemical Corp. and prior to that senior chemist with Transitron Electronics Corp.

James P. Murray: Boeing Airplane Co.'s Washington representative for thirty-one years, has retired but will continue as an advisor to the company. He has been a vice president for many years and one of the nation's first airmail pilots, having flown in World War I.

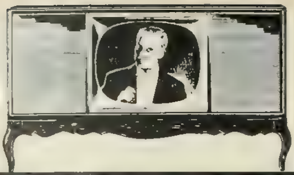
Clifford E. Roberts, with Boeing since 1946, now manages the Washington office.

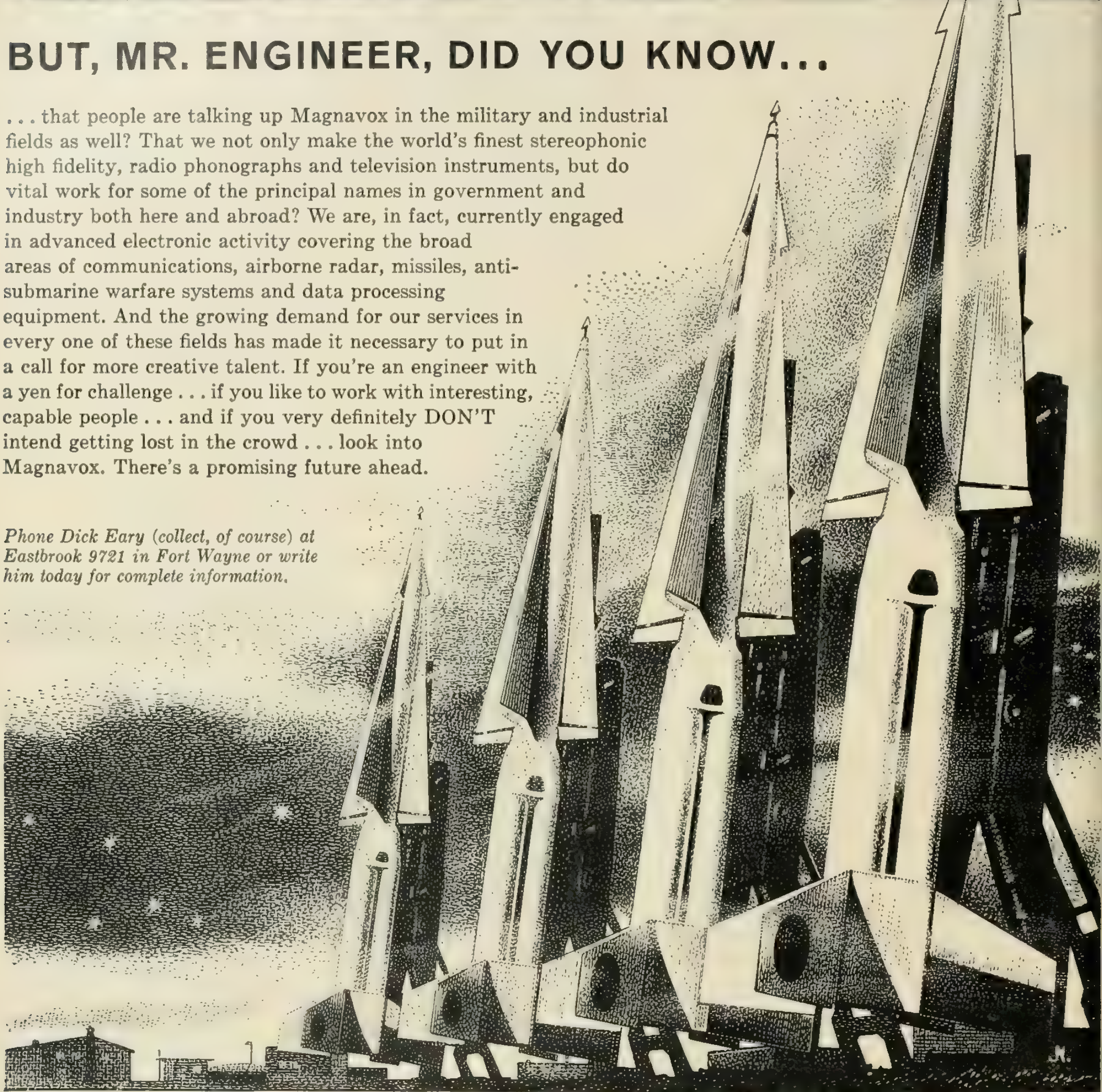
Lawrence S. Churchill, Jr.: joins Stavid Engineering, Inc. as engineering consultant in underwater electromagnetic propagation and ASW projects. He was formerly a member of the technical staff of Bell Telephone Laboratories, Inc., engaged in research and development and systems engineering in connection with underwater sound and sonar systems.

The Pall Corp. appoints the following to four newly-created engineering posts: **Charles H. Hacker,** chief engineer industrial filters; **Martin Kurz,** manager of porous metals; **Stanley Sakol,** assistant sales manager and **Morris Sankey,** director of quality control.

Dr. S. Dean Wanlass: former marketing manager, elected to the newly-created position of manager of product planning for Aeronutronic, division of Ford Motor Co.

Prior to joining the division he was manager of the inertial navigation department of Lockheed Aircraft's Missile Systems Division, Ramo-Wooldridge Corp. and Hughes Aircraft Co., where he made important contributions to the ICBM and *Falcon* weapon systems.





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FIELD ENGINEERS

Thumbing through the pages of this magazine points up a salient fact—there's a field engineer shortage, or at least, there's a shortage of good ones. The only investment an engineer has to make in order to change jobs is a short resume, a 4¢ stamp and an envelope. But what does the new job mean? Does it mean more routine work in a different location, and a few extra dollars in the paycheck; or does it mean the opportunity to utilize all your skills in a position where you can really move ahead? ● If the job turns out to be the former, you've spun your wheels professionally. On the other hand, if the job requires real use of your technical talent, and it's with a growing, wide-awake organization, then your future is just about what you make of it. ● This brings us to what we want to say about our organization—General Electric's fast-moving Ordnance Department. We're not Utopia for a field engineer, but who is? We're fast on our feet, and we want field engineers who can keep the present hardware going while formulating new equipment and systems concepts. There's plenty of opportunity to employ "blue sky" thinking as long as you can plug it into a solid engineering approach. Field engineers are important to our future because they deal directly with our customers, and success in this area means just one thing—more business for us. ● If you're convinced you've got to change jobs, why not let us tell you how a field engineering position with Ordnance Department will lead quickly to an advanced position in R&D, manufacturing, marketing or product service management.

LET'S FACE FACTS

● **Immediate assignments** are available on such advanced weapons systems as Polaris, and the Atlas Tracker Antenna—if you have a BSEE or BSME with 2-4 years experience in electronics weapons systems, computers, transistors, gyros, ballistics, telemetry, data analysis or servo systems. ● Assignments are principally at domestic bases that include Portsmouth, N. H.; Charleston, S. C.; Newport News, Va.; Key West and Cape Canaveral, Fla.; Mare Island (S. F.) and Sunnyvale, Calif. ● **Please write, including salary requirements to: Mr. R. G. O'Brien, Rm. 73WB.**

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ORDNANCE DEPARTMENT
OF THE DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

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editorial . . .

Space Program—Direction by Default

One of the main problems with the nation's space program is that no one is really running it. Partly through lack of time and partly through lack of appreciation, the President has declined the assignment. By default most of the decisions these days are being made by Dr. T. Keith Glennan, Administrator of the National Aeronautics and Space Administration.

Under the provisions of the National Space Act—and at the insistence of the Administration—Congress made the President Project Officer for the American space program.

The act specifies that he shall "survey all significant space activities, including policies, plans, programs and accomplishments; develop a comprehensive program; designate and fix responsibility for direction; provide for effective cooperation; resolve differences arising among departments and agencies . . . including whether a particular project is an aeronautical and space activity."

The attention of a very busy President is directed to the space program on those infrequent occasions when he meets with the National Aeronautics and Space Council, of which Dr. Glennan is a member. On these occasions, we are informed, the NASA chief briefs the President for 30 minutes, before the program, and items on the agenda are disposed of at the meeting without debate. Dr. Glennan suggests the action or lack thereof and the President nods concurrence. Thus the program is set.

This is hardly what Congress had in mind and we doubt it is what the country—as it watches us fall further and further behind the Russians—wants. For one thing, it indirectly and inadvertently gives NASA a powerful and perhaps decisive voice in determining the military role in space. This the National Space Act rather specifically prohibits.

For another, it places in the hands of one man a great deal more authority than was contemplated when his job was created. The written law says that the NASA Administrator shall "plan, direct and conduct aeronautical and space activities" (except military) as programmed by the President. The law presumably did not intend that the chief of NASA should be dictating the national space program.

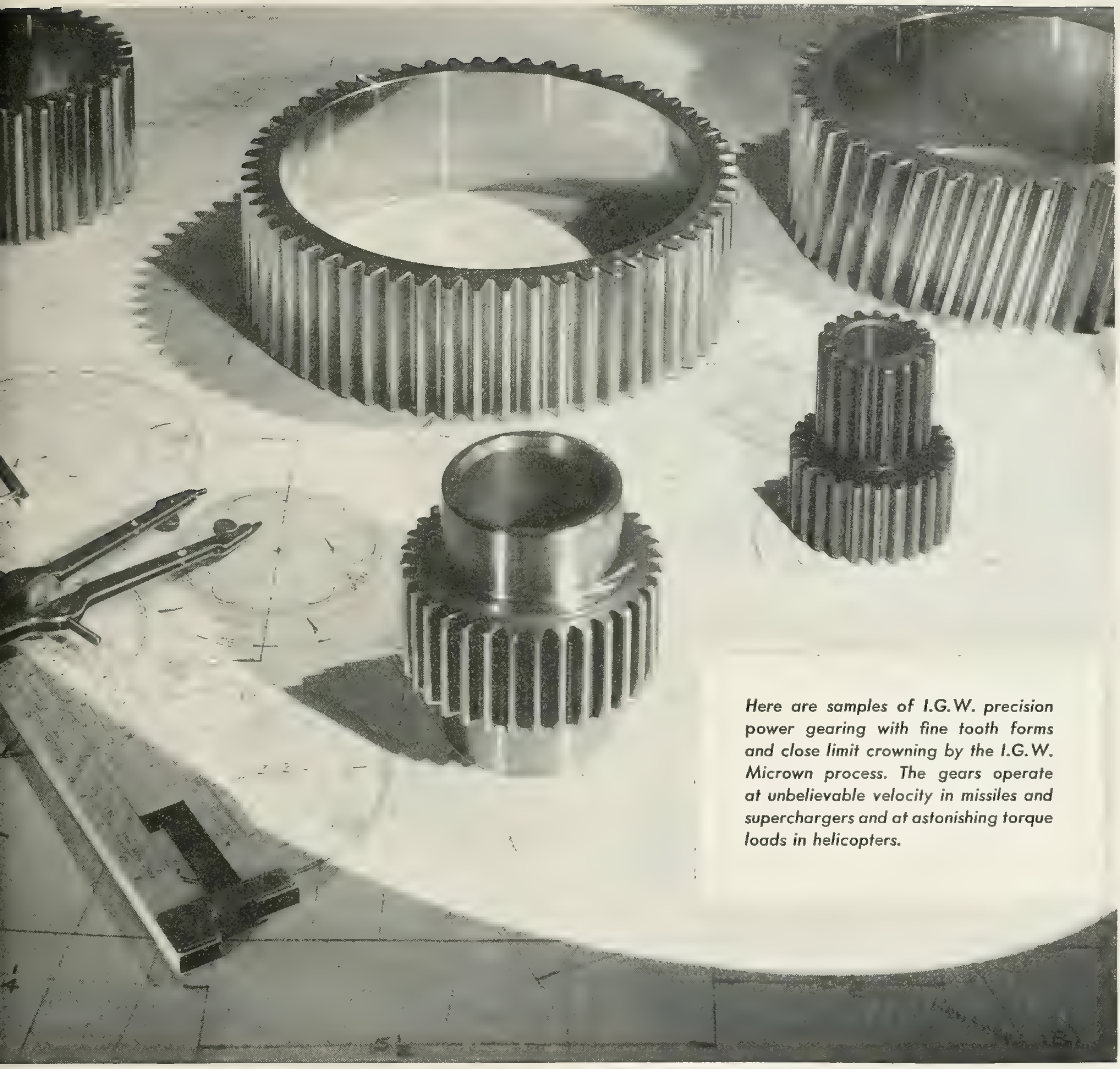
With the reconvening of Congress, several committees have announced firm or tentative plans for conducting thorough investigations of the U.S. space program.

We would like to suggest that the House and Senate Space Committees, as the groups most concerned, point their investigations toward a consideration of reworking the law to:

- Relieve the President of his assignment as Project Officer for the space program, a task he can't possibly have time to carry out.
- Change the charter of NASA from programmatical to functional. Give NASA the job of *exploring* space.
- Reaffirm the military role in space to clarify the grey areas now existing between the Department of Defense and NASA.

There's no real need for all this confusion about space and its use—peacefully, commercially, militarily or what have you. Space is a place—not a program. Let NASA explore it. Let the Services be prepared to defend our right to use it. And let the other government agencies (such as the Department of Commerce for weather forecasting) and private industry make hay with what the explorations produce.

CLARKE NEWLON



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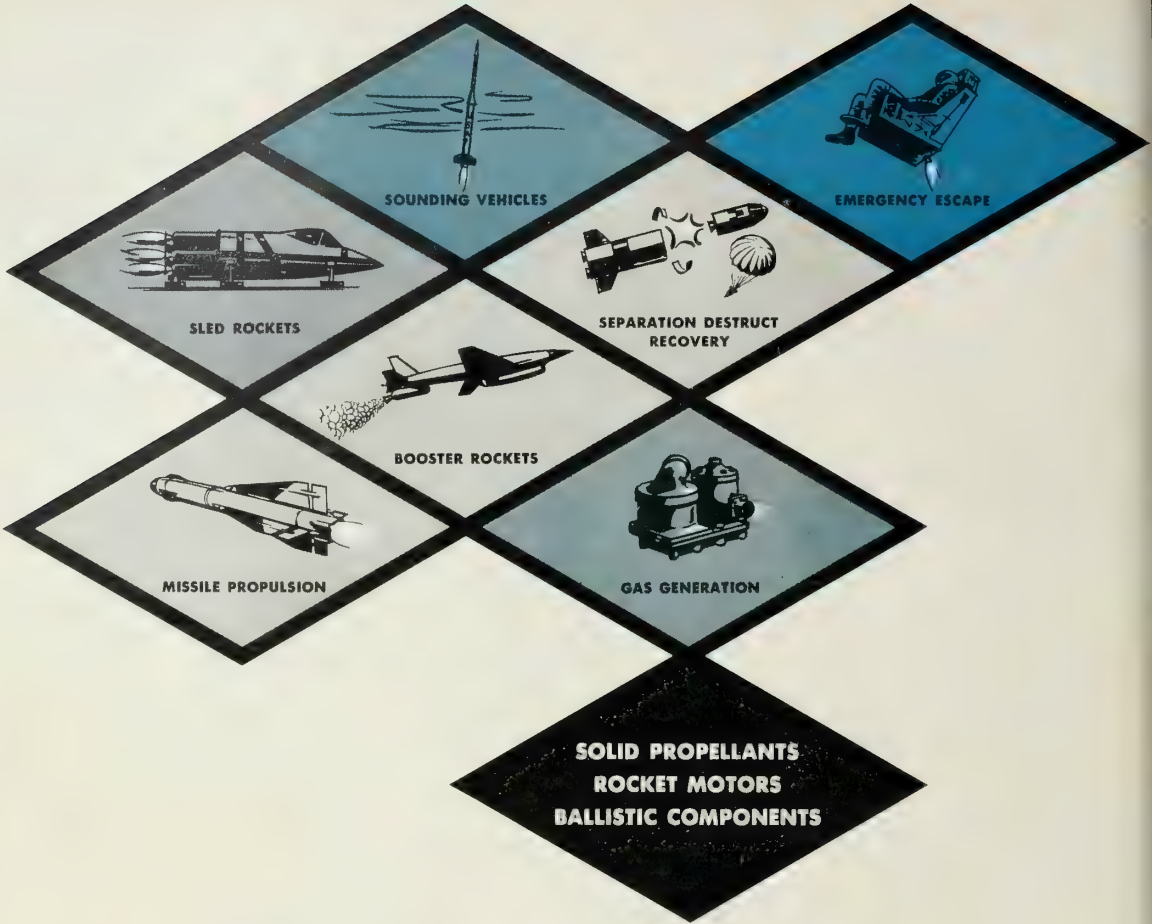

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JANUARY 18, 1960

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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Missiles and Rockets Volume 6 Number 3

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COVER: Final remelting of primary titanium ingots is accomplished in a consumable-arc double-melt vacuum furnace at Titanium Metals Corp.'s Henderson, Nev., plant. Huge ingots are ready for missile makers.

RIBBON-WRAPPED channel chamber is removed from brazing furnace at Solar Aircraft Co. at completion of brazing cycle in novel technique employing U-channels to make thrust chambers. See p. 14.

CHAFF ROCKETS developed by the Sandia Corporation stand ready to study RF attenuation caused by nuclear detonations. A story on the firm's unique role starts on p. 19.

FIN IS mounted on sled prior to high-speed test at Holloman AFB, N.M. Little publicized, such testing is of vital importance to missile development. A report starts on p. 26.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

30,900 copies of this issue printed

JANUARY 18 HEADLINES

ASTRONAUTICS ENGINEERING
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NEW MISSILE PRODUCTS

THE MISSILE WEEK
U.S. Reg. Pdg.

DEPARTMENTS

Washington Countdown

IN THE PENTAGON

ICBM squadron increases . . .
planned by the Administration are reported to be more illusory than concrete. Rather than a speed-up to meet the Missile Gap, the increases are understood to be a follow-on program stretching into the mid-1960's.

• • •

***Dyna-Soar* is walking . . .**
not running—under the present funding of the big Air Force project. On the present schedule, the **Boeing** space bomber is expected to be operational about 1969 or 1970. However, a big speed-up in funding could cut the time to 1966.

• • •

***Transit* is slipping . . .**
at least a month behind in its R&D test schedule. The next of the ARPA-Navy navigational test satellites now will be launched in March instead of February. Delay in getting a booster is reported to be the reason.

• • •

Cash for *Zeus* . . .
obligated by the Army through FY 1960 stands at a total of $590 million. Official Army figures on total direct obligations for the big **Western Electric** AICBM are $70 million for FY 1958 and before, $220 million for FY 1959 and $300 million for FY 1960.

• • •

The new name *Sky Bolt* . . .
is the only thing new about the **Douglas** ALBM, despite widespread headlines. Seven-month old design studies for the Air Force missile are continuing while the Defense Department makes up its mind whether the missile ever will be developed.

• • •

Fundless *Suzano* . . .
ARPA's space platform project, has disappeared altogether. The project has been cancelled in the latest reorganization of ARPA.

ON CAPITOL HILL

The curtain goes up . . .
during the week of Jan. 18 on three congressional space and missile investigations:

. . . Defense Secretary Thomas S. Gates will be the first witness at hearings before the Senate Armed Services Committee Jan. 19.

. . . Secretary of State Christian Herter on Jan. 20 will open the sweeping hearings planned by the House Space Committee.

. . . Gates will open hearings before the House Armed Services Committee Jan. 21.

The key issues . . .
that the congressmen will dig into include:

. . . The Missile Gap and how it can be filled.

. . . The Space Lag and the failure of the Administration to spend enough to catch up with Russia.

. . . The lack of defense against Soviet ICBM's and the decision not to go ahead with production of the *Nike-Zeus* AICBM.

. . . Whether U.S. limited war capability should be expanded.

• • •

Another reorganization . . .
of U.S. space programs as indicated by President Eisenhower is receiving a cool reception among congressmen. Many are beginning to feel that shuffling the pieces around the board is not the answer to Russian successes.

AT NASA

The big "doubled space budget" . . .
read into President Eisenhower's State of the Union Address is the offspring of poor semantics and wishful thinking. The President said the Administration would double space expenditures in FY 1961—not double the space budget. NASA spent only about $300 million on space in FY 1960.

• • •

Another delay . . .
has been added to the hard-luck record of *Thor-Able IV*—the belated sun-orbit satellite. Originally, it was scheduled to be launched last June . . . then last Dec. 15 . . . then Jan. 15. NASA and **STL** hope to have the sensitive payload ready to go sometime in February.

ALONG EMBASSY ROW

Initial French funding . . .
for SEREB—the organization set up to develop a French IRBM—is about $1.2 million. Meantime, the French are sounding out the British on cooperative development of a whole line of missiles including the **de Havilland** *Blue Streak*.

• • •

Atlantic polar launchings . . .
over Cuba and Panama may be coming soon. U.S. officials are reported to be checking informally whether the two Latin American countries would agree to the launchings from Cape Canaveral.

Industry Countdown

MANUFACTURING

Look for renewal . . .

of the *Bomarc-Nike-Hercules* battle for funds in the forthcoming budget hearings. Industry sources say the AF wants to triple the number of planned launchers for the 400-mile **Boeing** *Bomarc*—from 504 to around 1624. The FY '61 budget reportedly will contain $400 million for production of *Bomarc*. This may eat into appropriations for the build-up by the Army of its point defense *Nike-Hercules* made by **Western Electric.** There is also some agitation to harden *Bomarc* installations and this could further complicate the scrap over how much should be spent on the two interceptor missiles.

• • •

Big Navy contract . . .

in the works now is for a sub-chasing hydrofoil which presumably would carry nuclear depth bombs. Boeing and **Puget Sound Bridge & Dry Dock** (a **Lockheed** subsidiary) are among several companies in the competition.

• • •

Switch in NASA patent . . .

policy is now in the congressional mill. Legislation has been introduced to allow NASA more flexibility to waive its claim to title on inventions developed under its contracts. The measure (H.R. 9484) was requested by NASA to bring the agency's patent rules more in line with those of DOD.

PROPULSION

Split ring deflector . . .

for rocket exhaust has been patented by the Navy (US 2,919,544). The deflector is mounted circumferentially around the nozzle orifice and is movable so it can deflect the exhaust in any desired direction.

• • •

First production runs . . .

of more than 100 *Polaris* motor cases are now in high gear with the return of steel supplies to normal. **A. O. Smith,** Milwaukee; **Norris Thermador,** Los Angeles, and **Kaiser Metal Products,** Bristol, Pa., are turning out the first-stage cases. Norris Thermador, Kaiser and Aerojet-Downey are making cases for the second stage of the solid-fueled, 900-mile missile.

• • •

Enlarged fuel cell R&D . . .

program is now under way at **Pratt & Whitney** and **Leesona Corp.** Leesona, with **National Research Corp.** of London, will conduct chemical and electromechanical research; P&W will be responsible for mechanical and systems development as well as manufacture and sales.

ASTRIONICS

NASA's *Mercury* tracking . . .

range is now expected to cost between $50 million and $60 million—more than double the original estimate when the contract was let last year. The contract is still being negotiated with a team headed by Western Electric.

• • •

Australia is competing . . .

in this country with gyro makers. It has come up with a patented gyro driving means (US 2,918,869) for short-range missiles.

• • •

First successful . . .

test of an inertial guidance system in *Polaris* was made in the shot from Cape Canaveral on Jan. 7. The system was designed, developed and assembled at Massachusetts Institute of Technology.

WE HEAR THAT—

Choice of helicopters . . .

among combat ICBM missilemen is the **Kaman** H-43B. Look for the AF to make some large buys of "choppers" this year to help solve the communications and logistic problem around dispersed ICBM sites . . . **Rocketdyne** will lay off about 600 personnel in California plants in the next few weeks due to reduced engine development work . . . Molecular electronics—or some similar technique—is now considered by the experts to be the solution to the reliability problem . . . **Telecomputing Corp.,** Los Angeles, is seeking to buy **Narmco Industries . . . General Telephone & Electronics** has formed a new subsidiary in the advanced communications field—**General Telephone & Electronics Laboratories** (see p. 30) . . . **Servonics Inc.,** Alexandria, Va., is thinking of splitting its stock—now selling for about $9 a share.

More About the Missile Week on Page 12

To assure a new order of reliability

MICRO-MODULE

EQUIPMENT

The micro-module is a new dimension in military electronics. It offers answers to the urgent and growing need for equipment which is smaller, lighter, more reliable and easier to maintain. Large scale automatic assembly will bring down the high cost of complex, military electronic equipment. Looking into the immediate future, we see a tactical digital computer occupying a space of less than two cubic feet. It will be capable of translating range, wind velocity, target position, barometric pressure, and other data into information for surface to surface missile firings. The soldier-technician monitoring the exchange of computer data will have modularized communications with the other elements of his tactical organization. RCA is the leader contractor of this important United States Army Signal Corps program and is working in close harmony with the electronic components industry.

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AF Attacks 'Secret' Navy Space Plan

Navy accused of pirating Dyna-Soar to build competing 'manned maneuverable space system.' Details of Navy's 'Ops 54' bid for top space role told in exclusive M/R report

by James Baar and William E. Howard

WASHINGTON—The Air Force is preparing to tell Congress that the Navy is secretly trying to use its Pacific Missile Range as a springboard to launch a competing military space program—including sailors in space.

The Senate Space Committee, which already is investigating the bitter Navy-Air Force struggle over PMR, is planning to hold public hearings probing deep into the issue in the next few months. The House Space Committee is expected to do the same.

There is widespread concern that the interservice dispute is jeopardizing the national interest. The Air Force wants it out in the open.

M/R has learned that Air Force officials are now ready to charge from the witness chair that:

- The Navy is working on a "manned maneuverable space system" that is a carbon copy of the Air Force's *Dyna-Soar* manned space bomber.
- The Navy is developing a "super" *Polaris*—possibly to be clustered—for use as a space vehicle booster.
- The Navy is seeking through its experts at PMR to "bleed" information from advanced Air Force programs to build up its own technical know-how in space.
- All of these moves are part of a top-level "master plan" laid down in a supersecret report aimed at giving the Navy a major role in space within the next few years.

• **Counterattack**—Navy officials are certain to counter that the Air Force—which DOD has given the primary military space mission—has "drummed up" this list of charges to block further development of PMR.

The Navy contends that it is merely trying to develop PMR according to its charter—a national range designed to service the missile and space programs of the Navy and any other user. On space development, the Navy program so far is comprised mainly of the development of the *Transit* navigational satellite. However, the Navy insists, as it has for some time, that it expects to have an operational need for other space systems in the future.

The Air Force rejoinder to this argument is that tracking, read-out instrumentation and other phases of the ground environment are all part of an operational military system and cannot be used in common.

Disclosure of the Air Force charges and the forthcoming congressional hearings follows the recent reports (M/R Dec. 21 and Dec. 28) of the new interservice space battle centered on the West Coast at Vandenberg AFB and PMR's adjacent Point Arguello.

• **Alleged master plan**—The Air Force is expected to build its case on the Navy's so-called master plan for space—known to insiders as the Connolly Report. This four-inch-thick document—prepared last summer by a committee headed by Rear Adm. Thomas F. Connolly for submission to Chief of Naval Operations Arleigh Burke—is understood to outline in technical detail Navy space plans for the next decade.

It's said that basic recommendations in the report have already been implemented. These include:

- Establishment of a special office, known as "Ops 54," under the Chief of Naval Operations to monitor and carry out the program.
- Establishment in the new Bureau of Naval Weapons of an office of the Pacific Missile Range and Astronautic Development. Connolly, an assistant chief of the bureau, heads it.
- Redesignation and reorientation of the Naval Missile Center, Point Mugu, Calif., to provide a Division of Astronautics and including new laboratories for bioastronautics, life sciences and other systems to support manned military missions in space.

• **Selective pushing?**—The Air Force charges the only projects the Navy is pushing for PMR are those to give it the capability for carrying out the long-range space programs laid down in the Connolly Report. By doing this the Navy hopes to "make a quantum jump" for equal status with the Air Force in space.

One example cited by the Air Force is the Navy's proposal to build a "multi-purpose" pad at Point Arguello capable of firing *Atlas, Titan, Thor, Jupiter* and the Navy's *Polaris*. Air Force sources claim that the Navy is angling to get NASA to pay for the project and is trying to prevent the Air Force at the same time from turning over some of its *Thor* pads at Vandenberg to NASA for *Thor-Delta* launchings.

"Instead of providing range service to the Air Force—the principal user of PMR," says one Air Force official, "the Navy all down the line is giving us competition from this tremendous thing it is trying to grow."

He said that PMR has a host of technical experts who evaluate every detail of Air Force projects they can get hold of, to see how they will fit into the Navy's plans. He said the Navy even tried to get—and was refused—a complete need-to-know of all Air Force Ballistic Missile Division space programs.

However, this official claims the Navy did succeed in "bleeding out" from **Martin** and **Boeing** information about the *Dyna-Soar* program for its own Manned Maneuverable Space System. Other Air Force officials say the Navy Ordnance Test Station, China Lake, Calif., is working on the clustering of *Polaris* and other propulsion systems for the MMSS.

The Air Force, moreover, contends that as chief user it has no need for most of the facilities that PMR has recently completed or under construction. These include such expensive items as a central launch control building, tracking facilities and a missile assembly building. It claims these installations only duplicate existing facilities at Vandenberg.

The Navy, on the other hand, claims these facilities are the heart of its long-range, \$4-billion program for developing PMR into the world's greatest space range.

The Air Force holds that these facilities are nothing less than the heart of the Navy's future competitive space program—built mostly at Air Force expense.

This is the issue that will soon be before Congress.

DOD Considers Asking Reds To Pacific 'Missile Match'

WASHINGTON — Pentagon officials now are considering a proposal to challenge the Soviet Union to a "missile shooting match" in the Pacific Ocean.

The proposal was made after the Russian announcement Jan. 7 that one or more rockets would be fired into the Central Pacific, starting in the period between Jan. 15 and Feb. 15.

Informed sources speculated that the big Soviet rocket might be used to:

• Test a Soviet reconnaissance satellite similar to the Air Force's *Samos*.

• Launch a manned capsule preparatory to putting a Russian space craft into orbit.

• Test a Soviet version of the U.S. *Dyna-Soar* space bomber now in the early stages of development.

Under the plan put forward by a top-ranking Air Force officer connected with the U.S. missile program, the Russians would be invited to use the so-called "splash net" of the Pacific Missile Range for a competition on missile accuracy.

The splash net is the instrumented ballistic missile impact area near Wake Island which has been used by the U.S. Air Force *Atlas* intercontinental missile.

Any decision to invite the Russians to engage in such a politically-slanted competition would have to be made, of course, at highest Administration levels. Such approval is not considered likely. It would, in effect, be acceptance of a challenge issued many months ago by Soviet Premier Khrushchev for a "rocket shoot" to compare capabilities of U.S. and Soviet missiles.

The Russian firings will be into the heart of a heavily instrumented area of the U.S. Pacific Missile Range operated for all services by the Navy.

• **Interloper**—Perhaps more significant from the U.S. military viewpoint, it also will take the Soviet rocket right into the teeth of the test range being set up to evaluate the *Nike-Zeus* defensive missile, which was developed specifically to knock down Soviet intercontinental ballistic missiles.

Nike-Zeus firings are scheduled to begin this year from Kwajalein Island. Facilities now are under construction there as well as at Johnston Island, firing site for target missiles to be used in *Nike-Zeus* testing, probably *Redstones* and *Jupiters*.

Center of the U.S. ballistic missile impact area in the Pacific at which the Russians could be invited to take aim is a target circle 20 miles in diameter located approximately 75 miles northeast of Wake Island. Exact impact points are monitored by SOFAR (sound fixing and ranging) units. Radar impact prediction systems also are used.

This U.S. impact area is, however, some 2000 miles west of the area the Russians have outlined for their use. It is not likely U.S. instrumentation in the area could easily be shifted to monitor the Soviet shot.

There is little doubt, however, that considerable U.S. effort will be devoted to following the Soviet rocket with the instrumentation already available at the other range areas in the Central Pacific.

National Aeronautics and Space Administration Chief T. Keith Glennan already has offered to let the Soviet Union use the U.S. *Mercury* tracking network in its man-in-space program.

NASA Accepting New Bids for *Saturn* Stages

WASHINGTON—NASA announced last week it was accepting bids for *Saturn's* second and third stages which indicates that a timetable for the ABMA project will be:

• Firing of first stage 1.5 million lb. thrust cluster with dummy upper stages in 1963;

• Firing of two, three, and four stage configurations in 1964-65;

• Firing of four and five stage configurations in 1965-66.

The NASA-DOD announcement (predicted by M/R Dec. 14, p. 9, 38) gave ABMA the authority to initiate negotiations with industry for a second stage cluster of four liquid hydrogen-LOX engines producing more than 600,000 lbs. of thrust, and a third stage configuration of two engines producing about 300,000 lbs. of thrust.

The fourth stage will be four of **Pratt & Whitney's** *Centaur* XLR 115-P-1 engines producing 80,000 lbs. of thrust, and an optional fifth stage would be two of these engines.

The above timetable could be speeded up if NASA funds *Saturn* for more money than ARPA intended to, and if the second and third stage hydrogen engines experience rapid development.

Because the Pratt & Whitney engines will be ready before the second and third stages, the ABMA *Saturn* team may design an interim configuration using the third and fourth stages atop the *Saturn* cluster.

news briefs

• **Washington**—Missile and aircraft contracts accounted for 64% of defense contracts for more than $500,000 awarded to 100 major contractors and 129 subsidiaries in FY 1959. This compares with 60% in the period Jan.-Dec., 1958.

• **Nice, France**—Soviet Space Expert A. A. Blaganravov said the French have expressed interest in having the Russians launch a French satellite into orbit with a Soviet space vehicle. He said Russia will consider the project if France proposes it officially.

• **Athens**—The Greek government reported that NATO is considering establishment of a missile training center in Greece. It said it would agree to establishment of the center if NATO decides to put it on Greek soil.

• **Washington**—The Army awarded $35,271,000 in contracts to **Raytheon** for various phases of the *Hawk* program. The biggest contract—$18,287,000—is for the missiles themselves. The other two are for engineering services and field maintenance equipment. All work will be done at the company's plant at Andover, Mass.

• **Washington**—The Navy is postponing construction of $300 million worth of missile ships (one cruiser, three frigates) because of cost increases since the drafting of the FY '60 budget. There was no indication when work will start.

• **Washington**—Air Force Chief of Staff Thomas D. White indicated he would be willing to defend before Congress development of the B-70 bomber against Administration budget cutters. When asked about the B-70, White said "you can be certain I'll testify honestly and according to my convictions." He said there is still a need for this high-performance aircraft for launching ballistic missiles at 70,000 ft., airborne early warning and fast transport of tactical missiles.

• **Andres AFB, Md.**—The Air Research and Development Command is reported to be planning two major organizational changes: the Ballistic Missile Division would be made the Ballistic Missile Development Division with more operational control of development programs; the Air Force Office of Scientific Research would become the Air Force Research Division.

Conference Expected to Attract 800

LT. GEN. BERNARD SCHRIEVER
. . . Goddard Dinner Speaker

KRAFFT EHRICKE
. . . Tuesday Luncheon Speaker

ARTHUR KANTROWITZ
. . . Wednesday Luncheon Speaker

WASHINGTON—The third Annual Missile/Space Industry Conference will be held in Washington on Tuesday and Wednesday, February 16-17 at the Sheraton Park Hotel under the sponsorship of the National Rocket Club. The theme of the meeting will be The Space Challenge.

The conference, expected to attract some 800 industrial and military leaders in the missile and space field, will culminate in the Dr. Robert H. Goddard Memorial Dinner, Wednesday night, Feb. 17. Among the guests of honor will be Mrs. Esther C. Goddard, widow of the pioneer rocket scientist.

Principal speaker at this dinner will be Lt. Gen. Bernard A. Schriever, Commanding General of the Air Research and Development Command. Master of ceremonies will be Peter Hackes, NBC radio and television commentator.

Four panels are scheduled for the conference, two each day, following the Space Challenge theme, as follows:

Tuesday morning: "Philosophy and Policy," moderator Dr. S. Fred Singer, Professor of Physics, University of Maryland. This panel will be composed of leading space scientists and officials and proposes to go into the significance and meaning of the challenge man faces in exploring space.

Tuesday afternoon: "Legislative Aspects," moderated by Theodore F. Koop, CBS vice-president and former president of the National Press Club. This panel, to be drawn from the Senate and House Space Committees, will discuss new space legislation, changes in present laws and whether or not the U.S. space program is likely to become an issue in the coming national elections.

Wednesday morning: "Future Space Programs." This panel will be conducted by Kurt R. Stehling, Aeronautical Research Scientist, NASA, and will be composed of NASA and other government officials. It will attempt to point out the direction and progress of our national space program and perhaps give something of a forecast of the future.

Thursday afternoon: "Missile/Space Marketing." This panel will be moderated by a top official in the Defense Department office of Supply and Logistics and will be made up of procurement officers of the Army, Navy, Air Force, ARPA and NASA. The panel will discuss recent changes in missile/-space procurement due to new agency alignments and shifts in policy recently effective in the services.

Luncheons will be held each of the two days. Speaker for the luncheon Tuesday will be Krafft Ehricke, assistant to the Technical Director, **Convair Astronautics Division.** Dr. Arthur Kantrowitz, vice president and director **Avco Corporation** and director of the Avco-Everett Research Laboratory, will address the Wednesday luncheon.

Three awards will be presented at the Memorial dinner Wednesday night:

The Dr. Robert H. Goddard Memorial Trophy, awarded by MISSILES AND ROCKETS MAGAZINE. Previous winners have been Dr. Wernher von Braun of ABMA, and S. K. Hoffman, **Rocketdyne.**

The **Borg-Warner** Missile Industry Award. Previous winners have been **Lockheed** and **Rocketdyne.**

The Astronautics Engineer Achievement Award, previous winner Dr. Rudolph F. Hoelker.

General Chairman of the Conference is N. P. Jackson, Manager of Government Office, **Joy Manufacturing Co.,** Washington. Jackson defined the objective of the conference as follows:

"To promote policies, programs and legislation necessary to establish and maintain United States space leadership, and to stimulate civil and military space programs for the benefit of mankind."

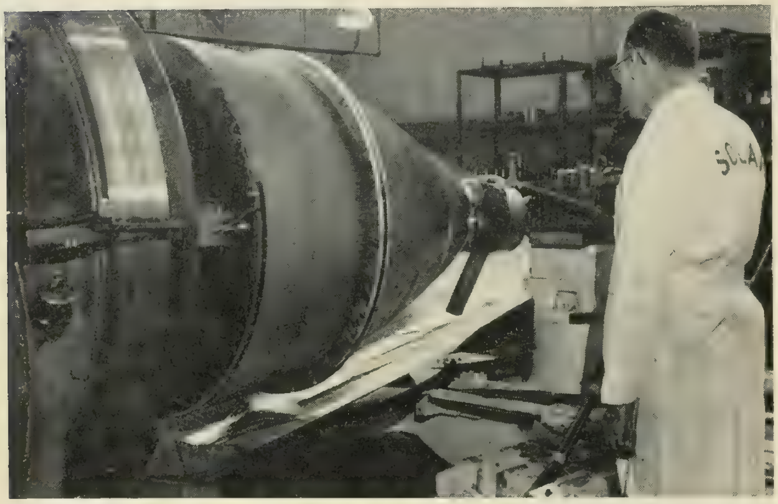
STL Moves Into New 40-acre Facility Complex

LOS ANGELES—**Space Technology Laboratories Inc.** has announced consolidation and expansion of its operations with a move to new facilities in El Segundo, Calif.

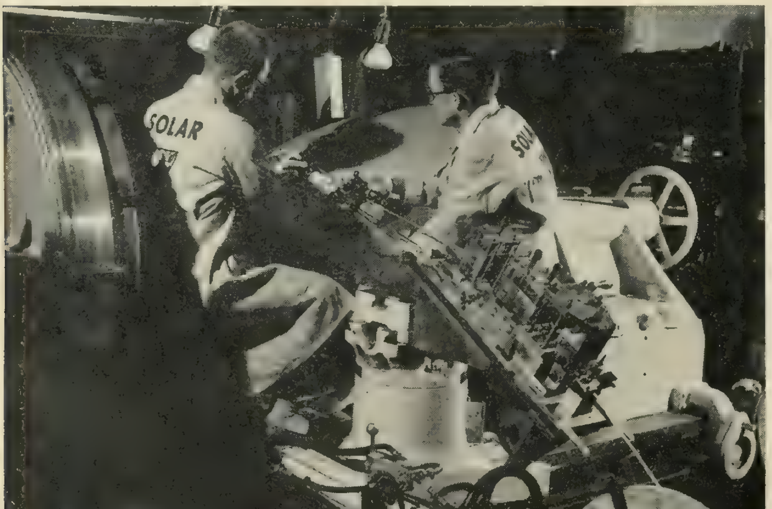
The new STL complex of eight buildings occupies an area of nearly 40 acres. Buildings contain some 900,000 sq. ft. of office and laboratory space for the more than 4600 STL technical and administrative personnel.

STL, a former division of **Ramo-Wooldridge,** provides systems engineering and technical direction to the *Atlas, Titan, Minuteman* and *Thor* programs. The research firm, employing more than 1500 scientific and engineering specialists, also assists ARPA and NASA in advanced space technology experiments.

U-Channels Used to Make Thrust Chambers



ON LATHE, thrust chamber is electroground following spot welding of channels. This precision operation provides the highly accurate geometry demanded by the design concept of the unique chambers.



AFTER GRINDING, while still on the lathe, the turning chamber is wrapped with strips of ribbon-wrap and copper braze alloy fed out by Solar technicians from a spool geared to lathe's revolutions.

SAN DIEGO—An unusual concept fabrication of rocket thrust chambers- ribbon-wrapped, U-shaped channels- is being used by **Solar Aircraft Con pany** on a project for the Nation Aeronautics and Space Administratio

Designed for engine thrust rang between 13,000 and 20,000 lbs., tl lightweight, low-cost, brazed chambe will be used by NASA at the Lew Research Center in Cleveland, for tes ing new high-energy liquid propellant

The sheet metal channels provi an easy, yet precise, method of co trolling coolant passage area throug out the chamber by varying the fu coolant velocity to meet local heat co ditions.

In fabricating the chambers, 3(straight strips of 0.008 in. AM35 stainless steel sheet are blanked ou then formed and sized into a "U" cha nel in one operation on a one-piece d representing the angular segment of th engine.

• **Assembly**—Following this oper tion, 180 of the channels are assemble on a stainless steel mandrel that h been cast and machine-contoured to de sired chamber configuration. Then 18 more channels are joined piggy-back a the neck of the hourglass-shaped cham ber and gradually fed into a skirt wit the other 180.

The channels are racked, with th open side facing out, through the us of notched clamping devices, and the welded together with approximatel 100,000 spot welds. The welds ar easily and quickly applied in a specifi pattern to insure close fit-up and hol dimensional and configuration require ments.

The assembly is annealed in a hy drogen atmosphere to hot-size the cha nels to exact shape of the mandrel.

• **Grinding & wrapping**—The cham ber is then put on a lathe where th channels are sized and electro-groun to specified heights along the enti chamber length. This precision grin ing provides the accurate coolant pa sage geometry necessary to the desig concept.

Following the grinding, while sti on the lathe, the chamber is wrappe tightly with approximately 2650 feet 0.008 in. AM350 stainless steel ribbo This ribbon, along with a copper bra ing ribbon, is fed automatically aroun the chamber from a feeding spool gea ed to the revolutions of the lathe.

• **Brazing & cooling**—After wra ping, additional copper braze filler sprayed onto the chamber to provi external sealing of interlocked ribbon The chamber is then ready for brazin which will integrate the wrapping an channels into tube-like fuel passages.

Brazing is done in a welded muff with controlled argon or hydrogen a

osphere. In the brazing cycle, the iamber is taken above 1980°F in oout one hour.

After brazing, the chamber is slow- furnace-cooled to 1800°F to allow nstressed solidification; then it is re- oved from the furnace and air cooled room temperature. Protective atmos- iere is maintained to insure a clean sembly.

Hardware attachments such as fuel anifold, reinforcing rings and injector inge are fitted to the chamber and the cond braze operation begins. This kes place at approximately 1875°F. copper-tin brazing alloy is used in is operation.

• **Heat treating**—The chamber is achined to mate the injector and en- ne mount and the assembly is heat eated—necessary to achieve the de- ed metallurgical properties of pre- pitation hardened AM350. This is one in a split cycle of –100°F for ree hours followed by three hours at 00°F.

The chamber undergoes a series of sts including leak pressure using 200 i helium in the fuel passages while bmerged in a water tank.

The lightweight chambers stand out five feet high and measure 39 in diameter at the skirt, 7.8 in. in e diameter of the throat and 10.5 in. the diameter of the head.

The fuel manifold fits around the ck, and in operation the fuel enters e chamber here and flows down 180 annels to the gathering at the bot- m, then returns up another 180 chan- ls to the fuel injector at the top of e head.

ABOUT 100,000 spot welds are applied to channels in a specific pattern to insure close fit and to hold dimensional and configuration requirements of the chamber being fabricated for NASA.

Aerojet Builds Cell to Test 'Exotic' Fuels

SACRAMENTO—The **Aerojet-General orp.** is building a test cell at its liquid cket plant for development of new gh-energy rocket propellants. The fa- ity is designed to bridge the gap be- een laboratory studies and large- ale engine development.

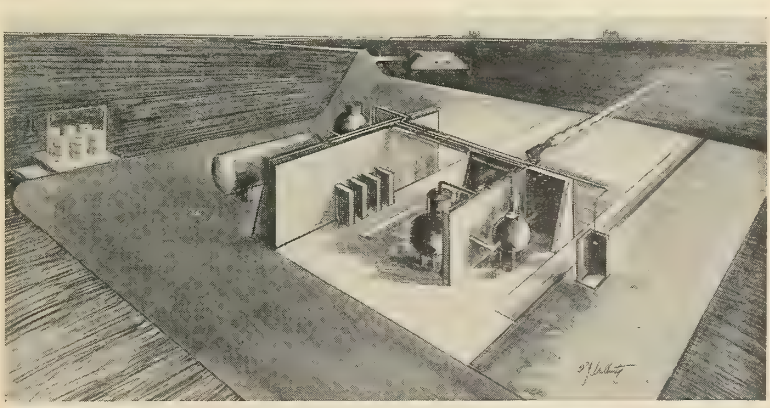
Performance data on engines in the 00-to-20,000-pound-thrust class will obtained, and engineers will gain perience in handling the exotic pro- llants. Operation is expected to com- ence in March.

Some of the propellants scheduled r test in the new facility are: liquid orine (F_2), nitrogen tetroxide (N_2O_4), hydrazine (N_2H_4), mono- ethylhydrazine (MMH), hydrogen roxide (H_2O_2), pentaborane (B_5H_9), rogen trifluoride (NF_3), perfluori- ted hydrazine (N_2F_4), and bromide ntafluoride (BrF_5).

A major portion of the work will aimed at the liquid hydrogen/liquid orine combination, giving the highest theoretical specific impulse among chemical propellants. A liquid hydrogen storage facility will be added to the site soon.

The test stand has been isolated from the general test area because of the toxicity of the propellants to be tested, and special safety precautions have been set up for operations, which will be conducted by remote control.

The facility, built with Aerojet funds, cost approximately $350,000.



ARTIST'S DRAWING of Aerojet's high-energy liquid fuel test facility.

Multiplexer Solves Telemetry Problem

CEC's Plexicoder handles millivolt-level inputs from many transducers, permitting high-volume telemetry without amplification

PASADENA, CALIF.—A novel approach to low-level PDM telemetry multiplexing has satisfactorily overcome noise and signal distortion, usually produced by its predecessors. (Pulse-duration-modulation (PDM) multiplexing is a means of providing high-volume telemetry—that is, a large number of transducer outputs time-share one radio frequency.)

Developed by **Consolidated Electrodynamics Corp.**, the unit commutates millivolt-level signals without amplification from as many as 90 transducers at rates up to 900 samples per second. Full-scale pulse duration is produced by a signal as low as 6 millivolts, said CEC.

Called "Plexicoder," the unit employs light beams and a photomultiplier tube to replace more conventional wiper-arm assemblies and chopper-stabilized amplifiers—often sources of signal degradation.

Chief feature of the unit, according to CEC, is its long operational performance—a minimum service-free life of 1000 hours with commutator life above 2500 hours. In addition, it is reportedly compatible with most standard telemetering equipment.

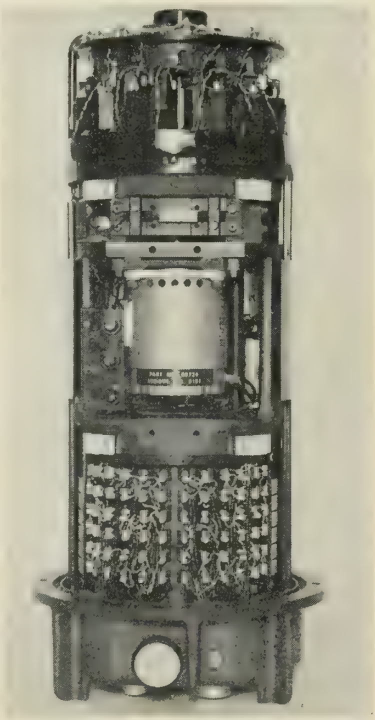
Low-level output transducers have been used widely in the missile industry for test applications because they meet the necessary requirements for accuracy and environmental tolerance. As requirements have become more demanding, the quantity of telemetered data from these devices has grown exponentially.

Multiplexing is especially desirable whenever steady state or slowly changing data are to be transmitted. Much elaborate wiring is eliminated, and regular and frequent sampling of transducers instead of a continuous record eliminates much superfluous data that must later be handled.

• **Troubles overcome**—In the past, multiplexing usually produced high noise level and signal distortion from wiper arm assemblies or mechanical commutators. The low-voltage levels of thermocouples and strain gages, often less than 10 millivolts, previously had not been successfully commutated by mechanical or transistorized switches. Also, amplification of signals before commutation was determined to be impractical because of the great number of channels to be sampled.

The Plexicoder uses light beams for commutation. A photomultiplier tube converts these light beams into modulated electrical impulses. The output of the tube and associated electronics is in reality an almost perfect square wave whose duration is a direct function of the original transducer signal. Error is less than 1%, according to CEC.

Normal operating range from –65° to 100°F will withstand static acceleration up to 30 g, and impact shock up to 15 g.



CEC's 80-pound Plexicoder, with cover off, features compact packaging, is only 25½" long. It is shock mounted.

Typical of uses that missile developers are making of this multiplexer is that by the Structural Plastics Division of **Aerojet-General Corporation**, Azusa, Calif. There it is used as a multiple, strain gaged, automatic, data-reduction system for measuring structural stresses of metals and plastics used in the fabrication of missiles and rockets. Currently it is being used in ***Polaris***.

The multiplexer is mounted on a mobile control console, which can be wheeled to the test site. Strain gages are wired directly to the Plexicoder inputs. The commutated data goes out on one line to a magnetic tape recorder. The tape is then sent to a central computer facility where data is processed and entered into a computer. It is now being used in testing Boeing's B52G, *Hound Dog* and **Convair's** *Terrier-Tartar* group.

• **Undistorted signals**—The principle of operation of the Plexicoder, said the company, eliminates any chance that signals will be distorted as they are being commutated. The incoming signal takes a unique path through the instrument.

A signal from the transducer deflects a galvanometer which reflects light from a light source. The reflected light beam is directed at a rotating disk in which is cut an aperture in the shape of a right triangle. As the triangular opening moves across the light path, light is admitted to the photomultiplier tube for a period of time proportional to the position of the light beam along the hypotenuse of the triangular opening. A voltage pulse is developed and maintained in the tube output for as long as the light beam strikes the photomultiplier tube.

Because the galvanometer, with its inherent filtering characteristics, is the terminating element in the signal input circuit of each data channel being sampled, filters between the transducer and commutator are unnecessary.

• **Operational sequence**—The switch assembly enables each of 15 galvanometers to sample six input channels in sequence. Operation of the Plexicoder can be shown by following a signal through one data channel.

The input signal is fed through a pair of glass-enclosed, magnetically

ctuated, hermetically sealed switches. This combination of two separate witches for each channel acts as a louble-pole, single-throw switch.

Each switch is magnetically biased o a normally closed position by a staionary magnet. Both switch and maget are potted in epoxy resin. The field f the bias magnet is nulled by a magetic field rotating on a flat disk on a lane whose arc approaches the two witches, and the spring constant of a novable switch leaf pulls the switch pen. The rotating disk, however, has radial gap of non-magnetic material. The magnetic field in the gap is insuffiient to null out the action of the bias nagnets, so the switch is closed by the ias magnet.

Because the stationary field of a ias magnet is used to close the datahannel switches during the critical peiod when the current through the witch is being converted to PDM, no noving magnetic field affects the signal ircuit. This type of switch is believed specially suitable for low-level signals.

The three actuating magnetic disks re mounted on a common shaft. Gaps re staggered 4° apart to keep the signals in sequence. Each switch is closed before the modulating circuit is timed to convert the electrical signal to PDM. Actually, they remain closed for a period of time required to sample 10 to 12 channels. There are always 12±1 closed data-channel switches. The rotating disk cutting off the light beams from the galvanometers does the actual commutating, however. All light beams except the one intersected by the triangular aperture are cut off from the photomultiplier tube.

When the pickup signal reaches the galvanometer via the data channel switch, the signal causes an angular deflection of the galvanometer light beam. The deflection of the galvanometer mirror, and the resultant displacement of the light beam, are directly proportional to the amplitude of the original signal source. The light beam from the galvanometer is reflected to the surface of the photomultiplier tube by two mirrors. The first is one of 15 toroidal mirrors (one for each galvanometer) mounted on a common base plate encircling the center shaft. The second is inside the shaft, to which light is admitted through a hole in the shaft.

• **Compatible speeds**—Short bursts of light passing through the triangular aperture strike the photomultiplier tube for a length of time proportional to the galvanometer displacement. Because the photomultiplier tube converts light energy into electrical energy, the burst of light is converted into a duration-modulated pulse in its output. The voltage pulse is reshaped electronically to form a perfect square wave.

These pulses are transmitted to data recording devices at speeds of 90, 112.5, 225 or 900 samples per second, depending on the choice of models. All these speeds are compatible with the standard IRIG (Interrange Instrumentation Group) playback speed of 900 samples per second by recording at the slower speed and playing back at a faster speed. For example, 112.5 samples per second recorded at a tape speed of 3.75 inches per second can be played back at 30 ips (eight times as fast). This time compression and expansion makes possible economies of tape and recording equipment.

The output also may be used to modulate directly an FM subcarrier oscillator or telemetering transmitter.

DOD Chided at Reliability Symposium

WASHINGTON—An accusing finger as waved at the military services here st week for too often waiving test equirements and lot-by-lot control proedures for electronic components in e interest of lower costs.

And the practice of "disproportionte" concentration on "breakthrough esearch"—instead of fostering more ong-range R&D programs aimed at general and systematic upgrading of eliability"—also was scored.

The remarks came from Julian K. prague, president of **Sprague Electric o.**, who delivered the opening address the Sixth Annual Symposium on Reability and Quality Control in Elecronics. Some 1100 scientists, matheaticians, and engineers from industry nd government attended the meeting ponsored by the Institute of Radio ngineers, American Society for Qualy Control, Electronics Industries Asociation, and the American Institute f Electrical Engineers. Some six forign countries were represented at the ree-day conference.

Sprague stressed that "reliability" nd "responsibility" are inseparable; but e said that unfortunately the two have een too seldom tied together.

• **Qualified bidders**—Sprague recmmended that current procurement ractices be altered to improve reliability on an overall basis. He proposed that the system of competitive bidding, where high levels of reliability are required, be limited to manufacturers who have demonstrated capability for meeting the required standards. This, he said, would assure that both grade and bid price would be factors in selecting a successful bidder—not just price.

Initially it is the responsibility of the Department of Defense to emphasize throughout the military structure the importance of reliability and quality as major weapon system ingredients, he said. In addition, DOD must insure uniform interpretation of these directives.

Secondly, he said, military departments must provide complete and uniform specifications—impartial and without loopholes. Departmental responsibility also includes broad dissemination of parts and materials data bearing on reliability.

• **Industry obligation**—Industry too must maintain an honest and conscientious policy striving for better reliability and quality control—and see that it is carried out, Sprague said. This means that the initiative to carry out a tough approach is needed to achieve reliability goals.

Some 65 papers were presented. Here are brief summaries of a few of the papers more specifically applicable to the missile/space industry:

• **Swapping data**—One unusual approach to reliability in ballistic missiles, is the IDEP (Interservice Data Exchange Program) described by Martin Barbe of **Space Technology Laboratories** *Titan* program office. Some 40-50 contractors will be involved in this program, exchanging test data generated by any ballistic missile contractor or service agency with all other ballistic missile contractors of all three services.

According to Barbe, this will do much to eliminate duplication without centralization of test facilities under a government agency or dictation of parts procurement policies by government. Expected actual cost savings were not included in the paper, but Barke said the program would undoubtedly bring significant savings in an annual national parts test bill now running close to $100 million.

• **Legal angle of standardization**—An interesting legal sidelight on the oft-repeated cry for standardization as a panacea for reliability problems was given by E. F. Howrey, former chairman of the Federal Trade Commission and now a member of Howrey & Simon, Washington law firm. Citing examples, he pointed out that industry

standardization programs are fraught with serious anti-trust dangers if not carefully planned and diligently administered. Even when not designed to achieve an illegal purpose—price fixing, production limitations, etc.—they may serve as circumstantial evidence from which an illegal agreement may be inferred.

• **Heat cuts failures**—Improvement in failure rate of silicon diodes can be delivered by high-temperature burn-in, according to a paper delivered by David Cowan of **Continental Device Corp.** He cited results of preliminary investigations that showed significant improvement in failure rate after 200° storage for 200 hours.

• **Redundancy no cure-all**—Redundancy, apparently, is not the total answer to reliability, either, as some proponents might have us believe. Work by **ARINC Research Corp.,** described by H. S. Balaban, shows that redundancy must be applied with careful concern for other factors—primarily, "reliability per dollar." One comparison between similar systems—one with two standard elements in active parallel and the other a single element—showed that after a certain time the non-redundant system had a higher reliability figure than the other. He pointed out that in many cases the use of improved elements in non-redundant configurations is equal to or better than a redundant system using less reliable elements.

The lack of data on past life-expectancy was cited by another ARINC member, J. M. Farrier, as a further problem in meeting reliability specifications. He spoke particularly of the notable deficiency of information regarding failure rates and operating characteristics of components under various environmental and circuit conditions.

• **Small sampling valuable**—Contrary to some beliefs widely held by quality control experts, small samples can be significant in missile failure control, according to S. J. Wilson of **Martin-Orlando.** Creative use of electronic computers and an integrated data approach have yielded economical and significant help in improvement of engineering decisions in the one-year-old Martin program described by Wilson.

• **Subcontracting reliability**—A program to assure reliability of subcontracted items was detailed by M. H. Saltz of **Hughes Aircraft.** Briefly, the Hughes program places responsibility for detailing the program on the bidder, an incorporation of agreed-to procedures in the contract, and close supervision and monitoring by the prime.

• **Building-block design**—The use of building-block methods in the design of test equipment as a new approach to automatic testing and fault location in large-scale electronic systems was described by D. H. Breslow of **Raytheon.** Two recently developed components—a comparator network and an expandable d-c voltage analyzer—are cascaded as necessary to analyze large systems and pinpoint malfunctions. Such a system is characterized by rapid fault location with a minimum of test equipment and engineering design time.

• **Batch testing**—Selected environmental tests on small samples of electrical and electronic parts can indicate quickly and cheaply any change in parts quality and reliability from earlier batches, according to D. C. Fleming of **AC Spark Plug Div.,** Milwaukee. He presents a list of critical parts for one type of ballistic missile guidance system, reasons for being critical, and the performance tests to which they were subjected.

TPR Promises Wide Military Potential

NEW YORK—Details of the new **General Electric** thermoplastic recording process (TPR) revealed here last week show promise of tremendous potential in all facets of military and space recording as well as broad commercial use.

Developed by Dr. William E. Glenn, of GE's Schenectady Research Laboratory, the technique has been likened in importance to the invention of photography, the phonograph, and magnetic recording.

The tape used in the developmental process is ordinary 16-mm film; only half the width was used for recording. The recording vehicle is a thin film of low-melting-point thermoplastic, forming the surface on the more heat-resistant standard film base. Between the surface film and the base is a very thin transparent conductor film. The recording, made in the form of small ripples on the surface of the plastic film, is impressed by an electron beam which horizontally scans the film surface. Tape motion provides vertical scan.

An electrical input, similar to a magnetic tape recorder, is used; the resulting image output, similar to photographic film, can be changed to an electrical output signal by standard optical-electronic techniques.

GE says TPR, even in developmental form, can concentrate 100 times as much information in a given space as can magnetic recording. With a digital system, 4 x 10^7 bits/sq. in. can be recorded. And it has the potential for a vastly greater concentration.

As an example of its speed, GE said TPR could record all 24 volumes of the Encyclopedia Britannica on a small reel—and it would take only one minute to record each volume.

Although like photography in that it provides an instantaneous recording and produces pictures in either color or black and white, TPR requires none of the chemical processing required by photographic film. In addition, it can be erased and reused as desired.

Company spokesmen stressed that much work still must be done before practical equipment is available for the military or commercial market. Original R&D was company-sponsored, but at least part of the work is now being done under a military developmental contract.

• **Military uses**—A multitude of military applications exist in radar and infrared detection, electronic countermeasures, missile guidance, and military communications. TPR has been described as a "natural" for military aerial reconnaissance and recording cameras. The instantaneous monitoring or readout which it provides has the obvious advantage of on-the-spot evaluation of results, so that a rerecording can be made if necessary.

It also was pointed out that TPR would be especially important in satellites and space vehicles where size and weight are critical. GE says satellites equipped with TPR might be assigned such complex duties as world weather reporting and military surveillance.

TPR promises to greatly extend the range and reliability of radar. It will greatly enhance hopes of devising a positive and instantaneous method of identifying radar targets—"optical correlation." M/R has learned that GE holds a classified Air Force developmental contract in this area.

Sandia Corp.: 1 Customer, 1 Competitor

Yet it deals with 3600 suppliers in $80-million facilities and holds the real 'trigger finger' in development of nuclear weapons for missilery

by Frank G. McGuire

ALBUQUERQUE, N.M.—No nuclear-tipped U.S. missile is developed without feeling the influence of the **Sandia Corporation.** From the first engineering drawing of a new missile to its final operational impact on target, Sandia has a finger—a trigger finger—in the program.

Sandia and its working partners, Los Alamos Scientific Laboratory and the Livermore Radiation Laboratory of the University of California, form an organization with one product: nuclear weapons . . . one customer: the military . . . one competitor: Russia. This organization, dealing with 3600 suppliers, has been described by former AEC Chairman Lewis L. Strauss as "the nation's biggest industry."

Although much of Sandia's work is still classified, the story of how it develops nuclear warheads for U.S. missiles can be told.

• **The "weaponizer"**—Employing 8000 persons at its $80-million facilities, Sandia "weaponizes" the nuclear explosive systems developed at Los Alamos and Livermore.

Formerly a part of the University of California, Sandia is now operated as a subsidiary of **Western Electric Company** under a non-profit contract with the Atomic Energy Commission.

Sandia is AEC's major laboratory for the non-nuclear phases of nuclear weapons research and development. It designs the electro-mechanical components necessary to make a basic nuclear device into a reliable nuclear weapon.

This includes fuzing and firing system design, component design (power supplies, timers, radars, barometric switches, and other circuitry), and casing or body design. After the weapon package is complete and proven, Sandia arranges for production of the weapon.

• **Heavy subcontracting**—Little actual production work is done at Sandia, most of it being subcontracted to manufacturers around the country. Over 50,000 separate procurement contracts are let by the company each year to more than 3600 suppliers in nearly every state in the country, and several foreign countries.

In carrying out its mission, the company engages in basic research in those scientific fields bordering on its activities, and applied research into new weapon concepts and improvements on current weapons. Development of the ordnance phases of nuclear weapons is then conducted before testing the weapon in laboratories and at the Nevada or Pacific test sites.

Further steps in the process include

SANDIA-developed chaff rockets studied RF attenuation caused by nuclear detonations in the *Hardtack I* series, with 65 firings.

manufacturing engineering for component and system production, delivery of the weapon to AEC, quality assurance and stockpile surveillance to guarantee reliability, and, finally, training of the armed forces in assembly and usage of the weapon.

When a nuclear weapon takes the form of a missile warhead, Sandia acts as a teammate of the missile prime contractor to assure compatibility of the warhead with the delivery vehicle. The weapon must be designed to fit the available space in the nose or re-entry body of the missile. In addition, it must meet all operational requirements.

• **Research areas**—To develop nuclear missile warheads and other weapons, Sandia has separated its research activities into five areas: fundamental research, applied research, weapons output studies, mathematics, and aerodynamics.

1) Fundamental research in the physical sciences is aimed at new knowledge and understanding in the fields related to Sandia's work. This embraces solid state physics, physical electronics, hydromagnetics, radiation effects, combustion processes, high temperature physics, theoretical mechanics, and geophysics.

2) Applied research, as its name implies, is aimed at a specific objective which Sandia hopes will be fruitful in weapon development. The emphasis is on understanding the physical phenomena involved, rather than engineering aspects. The applied research program is a continuous one, and is not affected by time scales established for the development of any particular weapon. Scientists investigate new fields of weaponry, searching for new and unusual components which might aid in nuclear weapon development.

3) Weapons output studies are conducted to establish exactly what happens when a nuclear weapon is detonated. Attempts are made to understand the physical phenomena associated with an explosion, rather than merely to study the damage caused. Much of the test data is gained through explosions of conventional materials in small amounts, rather than nuclear detonation.

4) Mathematical studies at Sandia cover systems analysis, statistics and numerical analysis. Evaluation of the role of nuclear weapons in warfare is carried out by system analysts, who then use the data to design weapons most likely to fit the needs of the military in any future conflict. Research and development activities are guided by recommendations from these analysts.

Statistical research is conducted on reliability and quality control of weapons, Monte Carlo processes, and design of various experiments. The mathematicians also act as consultants on applied problems in the development phases of programs.

5) Aerodynamic research and design must be a vital part of a project from the outset, if the weapon is ever to reach its target successfully. A casing, or aerodynamic shape, must be designed to house the weapon, and this must be compatible with the delivery vehicle.

Considerations included in such design are: parachute and drogue design, barosensing at high mach speeds, high-temperature effects on ballistic shapes, stability and control of weapons in flight and fall, and other phenomena.

• **Rocket test vehicles**—Included in Sandia's area of interest is information on high-altitude research. To carry out such studies, the company has designed its own family of high altitude test vehicles (Sandia makes no missiles). Data obtained from these is applied to future weapon design.

Latest of the test vehicles is the HAS rocket (the company declines to spell out its designation) which will take a 60-pound payload to 250-500 miles altitude. The recoverable vehicle is 304" overall and will cost about $30,000 per copy. The multi-stage vehicle consists of seven *Vipers* and a *Nike* or *Lance*.

In its rocket test vehicle program, Sandia subcontracts 75% of the work, producing an average of 35 to 40 vehicles per type developed. The most vehicles of one type ever produced was approximately 225. A high degree of organization and capability enables Sandia engineers to fire a vehicle on an average of six months after establishment of a requirement.

Built around shelf hardware for the most part, the vehicles use *Nike* boosters as workhorses, and recovery of about 75% of the payloads launched has been accomplished.

• **Special equipment**—To carry out its research and development activities, the company has a considerable amount of specialized equipment, and more under construction.

• A Van de Graaf accelerator capable of accelerating protons, neutrons, and electrons to energies as high as 2,000,000 electron volts.

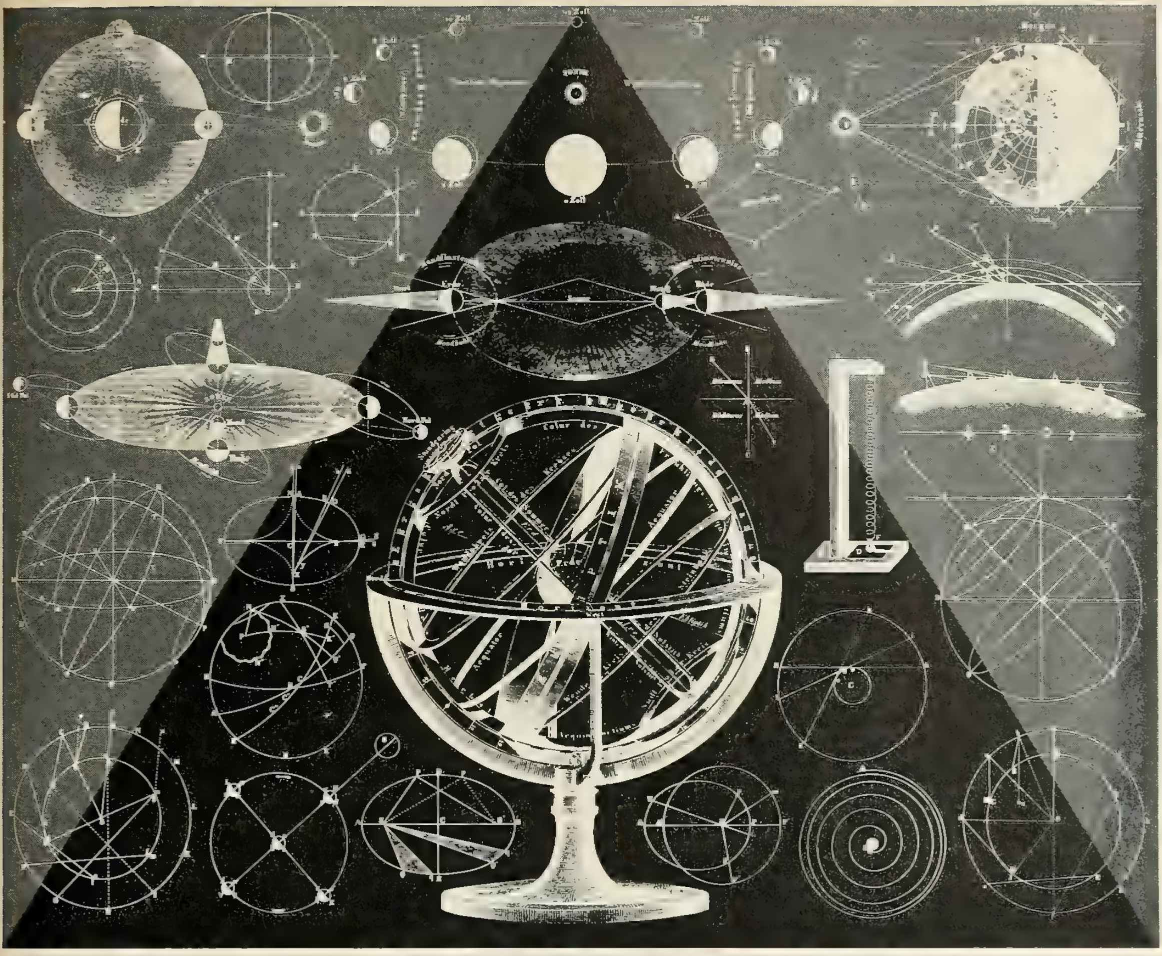
• A 5000 kw tank-type heterogeneous nuclear reactor for testing the effects of radiation on materials. (Under construction)

• Modern commercial and Sandia-designed analog and digital computers.

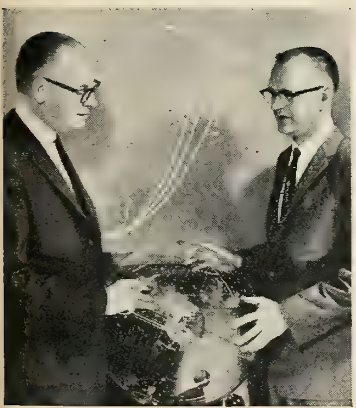
• Two high-temperature solar furnaces.

• Two high-speed wind tunnels. (Now under construction is a high-temperature, high-speed tunnel to provide wind speeds ranging from Mach 3 to Mach 9 at temperatures to 2500°F.)

• A 3000-foot rocket sled track



Guided tour
of the
solar system



The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects. Some of our requirements are listed in our column on the facing page.

Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

SINGLE-STAGE version of *Doorknob* rocket. Two-stage version developed by Sandia Corp. is capable of lifting 150 pounds to 250,000 feet.

with Mach 2 capability.

• A hydraulic centrifuge, one of the largest in the world, designed by Sandia, and several smaller centrifuges, including a rocket-powered model.

• A 300-foot drop tower for impact studies.

• A "slingshot" accelerator for impact and acceleration studies.

• Two field sites for scale model studies of blast effects, using conventional explosives.

• Test ranges at Salton Sea, California, Tonopah, Nevada, and the use of military ranges, such as Cape Canaveral and Point Mugu.

• An "air gun" with 26" inside diameter to subject components to initial accelerations as high as 5000 g.

• Complete environmental, electronic, mechanical, and chemical structure testing laboratories at Albuquerque and Livermore, Calif.

• Instrumentation for the study of nuclear and electron magnetic resonance, X-ray and electron diffraction, mass spectrometry, ultraviolet, visible, and infrared spectrometry.

• A 170-foot drop tower for heavier load tests.

• Low g test facility, which will deliver as low as zero-g.

• Acoustic test facility.

• Radiant heat facility with heat transfer rate of 500 btu per square foot per second.

• A 21,500-pound peak force complex wave vibration facility.

• Climatic exposure test chamber to simulate temperature, altitude and humidity.

• Material development laboratories.

Construction currently underway at Sandia, to provide better facilities and equipment, totals approximately $5 million.

• **Nuclear weapon development**—When a military requirement is established for a particular type of nuclear weapon, either warhead or bomb, and research has shown that such a weapon is feasible, development is under way.

The Atomic Energy Commission assigns Los Alamos or Livermore to concentrate on development of the nuclear components of the weapon (a phase still secrecy-shrouded), and the resulting basic nuclear device is handed to Sandia to be weaponized.

A project group at Sandia is charged with design of the complete ordnance system, as well as all individual components. The development engineers comprising this project group are primarily electrical and mechanical. They perform logical engineering steps in the overall development process.

First, a block design of the proposed system is laid out, with each block representing a separate function. Investigation then determines what component or group of components will perform that assigned task. If the desired device does not exist, either commercially or in a previous nuclear system, the component design department is asked to create one.

The component development engineers develop the devices for specific use in a system, as specified by the project group, with a sharp eye on reliability and ingenuity.

After accepting a design, the project group undertakes to package the weapon, meeting all the operational requirements. The final phase in the process is test and evaluation of prototype models, after which the design is released for manufacture. Project group personnel then aid in selection of suppliers, and suggest fabrication methods, as well as take part in tests.

The systems engineer therefore establishes requirements for new component development, designs and tests the complete system, and coordinates the work on the project from inception to stockpile.

Simplicity, ruggedness and reliability are prime considerations in the program. Prevention of both premature explosions and duds dictate greatest reliability. Efforts are made to use previously developed, tested and proven components before going about the job of creating new ones.

• **Environmental testing**—After fabrication of a prototype device in the model shop, which is believed to be the best equipped west of the Mississippi, environmental testing is begun.

High-temperature test: component is cycled for 30 tests of 24 hours duration, during which it is exposed to temperatures of 90 to 160°F.

Humidity test: component is exposed to relative humidities of 90 to 98% in ten 48-hour periods at temperatures of 68 to 149°F.

Temperature shock test: component is subjected to 160°F for four hours and −65°F for four more hours, three times.

Vibration test: mechanical resonant frequency is determined and the component vibrated at 10 g along each mutually perpendicular axis for one hour at room temperature; 15 minutes at 160°F and 15 minutes at −65°F.

Mechanical shock test: component is impacted 18 times at 15 g along each mutually perpendicular axis.

Acceleration test: component is subjected to 50 g along each mutually perpendicular axis in each direction.

Salt spray test: component is subjected to atmosphere of wet, dense, salt

fog for 50 hours at 95°F.

Other tests include subjection of components to high and low pressure, explosive vapor, fungus, sand and dust, rain and ice, and bright sunshine. Optimum efficiency is required throughout all these tests.

In addition to these environmental tests, Sandia has spectrographic, chemical and analytical equipment for materials testing. Lab equipment also includes that for determining measurements of length, mass, radiation, pressure, high and low electrical frequencies, and for determining magnetic resonance. Other equipment tests components and systems for effects of radiation.

• **Field tests**—Two basic types of field tests are carried out by Sandia: non-explosive and full-scale. The former consists of a complete system except for the nuclear components, with which ballistic behavior and electromechanical operation are studied.

Flight data obtained for analysis includes roll, yaw, pitch, accelerations, vibration at critical points, temperatures inside and outside the shell, internal and external pressure, structural strain, and voltages.

Sandia has developed a "DigiTel" data processing machine to select and punch test information onto IBM cards in digital form. The method represents considerable change since early nuclear days, when tin cans were placed at varying distances from an explosion, and pressure data gained from the extent to which cans were crushed.

Full-scale tests are carried out at the Nevada and Pacific test sites of AEC. Fissionable or fusionable material is detonated at these tests to prove out the design of an explosion system, and also to gain data on shock wave, heat, radiation, and other weapon effects. Such tests are sometimes conducted with nuclear "devices" which consist merely of nuclear material and a detonation system, rather than a complete, operational weapon. This enables Sandia and its partners in the program to test the explosive system before all the electro-mechanical details are worked out.

Upon completion of tests, Sandia arranges for production in desired quantities, inspection, delivery, storage, and stockpile surveillance. Production facilities are considerably decentralized, partly for security reasons and partly because of economic and time factors. Specialized facilities, even though scattered throughout the country, are valuable for the capability and experience they represent.

To coordinate the work of the widely dispersed facilities, Sandia has a corps of manufacturing engineers who maintain liaison between these plants and Sandia's facilities.

• **Quality assurance**—Although extremely reliability-minded, Sandia never freezes a weapon design, but frequently modifies existing weapons to improve their characteristics. This goes so far as to include reworking of already-stockpiled weapons, and in some cases, results in complete replacement of weapons with later models.

There are few areas where quality assurance is more vital than in a nuclear weapon. A continuing and intensive program is carried on by Sandia for the AEC and the military. For determining quality, the company has a four-phased approach including (1) Verification Inspection, (2) Destructive Testing, (3) Field Reports, and (4) Quality Surveys.

1) Verification inspection is based on examination of engineering drawings and specifications, resulting in establishment of later inspection procedures and pinpointing of specific characteristics to be checked, determination of sample sizes to be taken, and the acceptance criteria to be used. The amount and type of defects allowable are also established, based on the type of weapon and its relationship to other segments of the system.

2) Destructive testing, a self-explanatory term, leads to complete analysis of components, and in some cases, results in redesign of parts. Such testing is done at various intervals in the life of the weapon, so that effects of age may be determined.

3) Analysis of field reports follows Sandia's inspection of the military stockpile. Although maintenance of this stockpile is a military responsibility, Sandia provides technical assistance and instruction. Results are collected and punched on data cards, keeping a complete record of every weapon, from its production to its destruction.

4) Two types of quality surveys are conducted on a continuing basis: the Supplier Survey and the Product Survey. The former is mainly concerned with the facilities and performance of each supplier in the AEC network, and covers raw materials procurement, process controls, inspection methods and other quality-affecting factors.

The Product Survey examines the status of all drawings, specifications, factors affecting manufacture, and the maintenance of specific important material which may affect quality.

Although quality assurance provides AEC with information on quality and adequacy of the existing stockpile, it also provides feedback to the design and manufacturing agencies which results in improved weapons, as well as a means of producing future weapons more cheaply and with greater reliability.

• **Nuclear test ban**—The future path of Sandia Corporation depends on whether the ban on testing of nuclear weapons is continued or broken by either the United States or the Soviet Union. If the ban is broken, then Sandia will continue making even-more-deadly nuclear weapons.

If the ban is extended permanently, the company foresees a two-year period of fulfilling its present weapon-design obligations, then a greater channeling of its capabilities into Project Plowshare—the peaceful use of nuclear energy.

Navy Materials Needs Up For Review at AIME Meet

New York—First-hand descriptions of the Navy's needs in materials will highlight the annual meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers Feb. 15.

The one-day forum, sponsored by the Metallurgical Society of the AIME, will involve materials problems in deep-diving submarines, missiles, the metallurgical aspects of energy conversion and the development of naval weapons. The program also includes reviews of current Navy materials research programs in an afternoon session.

The forum concept will be used to present the Army's problems at the fall meeting of the Metallurgical Society in Philadelphia and the Air Force's defense questions will be handled at the AIME Annual Meeting, February, 1961, in St. Louis.

New Firm Tackling Boundary Lubrication

Fort Worth, Tex.—Boundary lubrication problems are the primary concern of a new firm, the **Almasol Corporation.**

A wholly owned subsidiary of **Lubrication Engineers, Inc.,** Almasol was founded by two lubrication chemists to provide customized products for particular applications—high-temperature lubricants.

The basic ingredient in the company's line is almasol, a material which retains its qualities up to 1900°F.

The new firm will not license or franchise its products or processes. It says the work involves an extremely high degree of precise quality control, and personnel must be thoroughly trained in the various operations.

Air Force Weighs Hardening of *Bomarc*

Decision on whether to bury launchers and disperse them is related to added cost and debatable value of making defensive weapon 'hard'; if done, 'twill be done quickly

WASHINGTON—A midstream switch from "soft" to "hard" underground launchers for *Bomarc* interceptor missiles is being contemplated by the Air Force.

M/R has learned that a recommendation has been made to harden and disperse *Bomarc* bases being sought in the 1961 budget. There is a possibility that some of the bases already funded, but still on paper, may also be changed.

However, the decision to go ahead is being weighed carefully in terms of increased cost and the strategic value—if any—of hardening a strictly defensive weapon that is effective only against aircraft. Time is the most important factor. It is argued that unless hardening commences at once it will have little value.

The main objective of hardening would be to preserve *Bomarcs* from an initial Russian ICBM or submarine-launched missile attack so they could be fired at an expected mop-up wave by DA (Russia's SAC) strategic bombers in the event of war within the next few years. By 1965, however, Russia is expected to have such a large missile capability that aircraft would play only a minor part in an all-out war.

Of the 14 *Bomarc* bases now in the North American Defense Command's program, only one—at McGuire AFB, N.J., guarding the Trenton area—is operational. McGuire has two squadrons, each numbering 28 *Bomarcs*. The two groups of shelters are closely clustered in rows and look much like a suburban home development. They could easily be erased by a single nuclear warhead.

Three other bases situated at Dow AFB, Bangor, Me.; Otis AFB on Cape Cod, Mass.; and Suffolk, L.I., are almost identical to McGuire. They are virtually complete and are expected to be operational before the year is out. Ten others are in various stages of construction, including two at Glasgow, Mont., and Malmstrom AFB, Mont., which are scheduled to be advertised for bids in April by the Corps of Engineers.

All 14 of these bases are costing more than $500 million total to construct and equip for combat use. While most presently are being restricted to either one or two squadrons, all are being designed to be augmented to handle a total of 112 missiles, four squadrons.

It is some of these later squadrons that are up for consideration for hardening, perhaps in the "Hollywood hard" type configuration that puts the top of the shelter flush with ground level.

Any decision to put *Bomarc* launchers underground would run up the construction cost—now pegged at $9 million per squadron of 28—by a factor of 30% to 50% depending upon the degree of hardening.

• **Shelter evolution**—If a hardened launcher is developed for *Bomarc*, it

EVOLUTION OF *Bomarc* **launching shelters began with this prototype Model I. The building required nearly 1000 tons of concrete.**

MATERIEL REQUIREMENTS were cut sharply in this Model II shelter now operational at McGuire AFB, N.J. The structure is steel.

would be another step in the evolution of its shelters which dates back to late 1952. The fully-automated launcher for the new 400-mile-range *Bomarc B* now being built for the nine most recent squadrons is a far cry from the prototype Model I launcher erected at the beginning of the program at Cape Canaveral.

In a paper given last week at the Society of Automotive Engineers annual meeting in Detroit, R.V. Ostling and P. M. Kelly of **Boeing Airplane Co.** show the Model I shelter to be a massive device in comparison to the latest, streamlined Model, 1V-A.

The preliminary design prepared by **Anderson-Greenwood Co.,** Houston, actually laid down the basic definition of the system which has been adhered to ever since. It embodied a horizontal-storage shelter with a hydraulically operated bi-parting roof and a permanently installed launcher erector.

This model—later modified to become the prototype Model I—was for the early version of *Bomarc* which required a fueling system for its **Aerojet-General** liquid booster. The "B" type missile eliminated fueling with its **Thiokol** 50,000-lb.-thrust solid booster. The upper stage is powered by two **Marquardt** ramjets—which burn a storable jet fuel.

The two Boeing Aero-Space division engineers report that soon after the Model I had evolved into a design in late 1955, it was criticized unfavorably for its excessive size, complexity and cost. Two of the more controversial features were an involved deluge and sprinkler fire protection system and an overhead traveling crane to handle the missile. Model I actually was considerably larger than the "low profile, compact configuration" of the preliminary shelter design by Anderson-Greenwood.

One Model I was built at the Cape and performed successfully. Four more were erected at Eglin AFB, Fla., for training at the same time it was decided to scrap this shelter for tactical use and redesign it. The result was the Model II, which is now operational at McGuire AFB.

In this model, the length was reduced from 75 to about 62 ft. and the height from about 28 ft. to approximately 15 ft. The width remained at approximately 60 ft. Total inside volume from something over 40,000 cu. ft., to a little less than 18,000 cu. ft.

The big reduction was in materials. The 950 tons of concrete required by the Model I was cut almost in half as was the 55-ton original structural steel requirement.

This resulted in a per unit price drop from $113,000 to $85,000.

• **Still not satisfied**—Ostling and Kelly say that even this substantial cut did not satisfy the Air Force. So the AF Office of Installations Engineers contracted for design and construction of a Model III prototype structure.

The Model III cost $76,830 based on 28 units per site, but it "represented the ultimate in mechanical complexity." Built on a concrete floor and foundation identical to the Model II, the Model III had a roof opening mechanism comprised of four rolling panels and four hinged panels operated by 12 hydraulic actuators—plus three chain drives and an electrical motor.

Just one was constructed before the concept was abandoned.

Boeing in August, 1958, obtained Air Force permission to design and prepare its own A&E drawings for what was to become the Model IV-A, still for a liquid-fueled booster.

The prototype of this model with its flat split roof was subjected to over 600 roof operating tests under simulated snow loads of 30 psf and wind loads up to 60 mph. Say Ostling and Kelly:

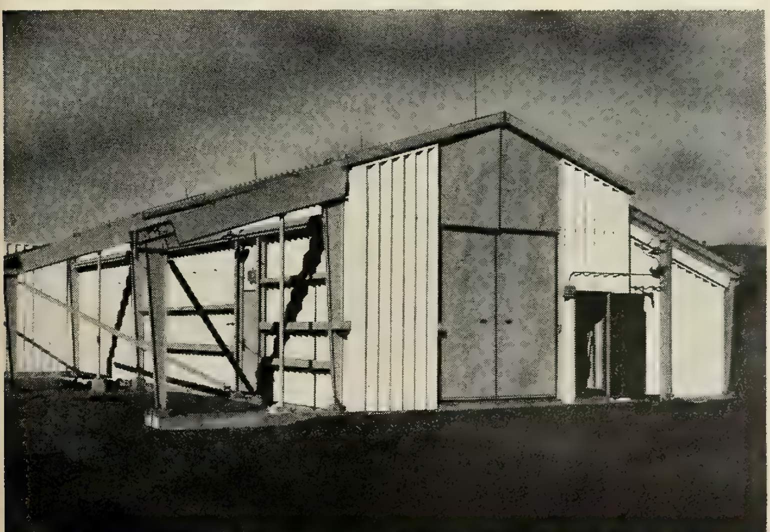
"Throughout, the roof opening proved to be fast (4 secs.), dependable and, of course, automatic. Additional tests have raised the total number of roof operations on this prototype to 1296.

"The heating and ventilating systems of the shelter also were thoroughly tested and found completely satisfactory, while the roof seals were tested under simulated rainstorm conditions and (also) found satisfactory. The electrical lighting, power, and control systems were thoroughly checked, and in addition, a laboratory test was run to select the most economical rolling roof support beams which would ensure freedom from wear and cold working during the operational life of a tactical launcher-shelter."

The "IV-A" has a per unit cost of $60,357. And its sister model for the *Bomarc B* costs $42,906.

This latest model also represents a rather dramatic reduction in cost of a 28-unit squadron. The Corps of Engineers puts the Model II at $13 million to build per squadron and the Model IV at $9 million.

Further reductions in squadron costs appear unlikely—particularly if the Air Force decides to go ahead with the hardening of *Bomarc* bases.



THIS IS THE ONLY Model III shelter yet built. While cheaper than Model II, this type proved to be "ultimate in complexity," so Air Force quickly dropped it.

LATEST MODEL IV has roof which opens in 4 sec. New squadrons will use it.

Sled Tests Evaluate Fin Materials

There's little glamor in such 'pick and shovel' testing but important data is gained along Holloman's seven-mile-long sled track

PYLON for fin mounting to avoid aerodynamic interface with the sled was fabricated by AFMDC personnel to Narmco recommendations. During static tests, loads were applied to the pylon at the predicted center of pressure under maximum fin loads. Procedure enabled determination of load-deflection curves for pylon and to proof-load pylon and sled in a structural check.

HOLLOMAN AFB, N.M.—Evaluation of components through high-speed sled testing probably is one of the most underpublicized phases of missile activity.

Although relatively unromantic compared to big, blasting vehicles launched from Florida or California, detail testing is no less important.

The photos on these pages show "pick and shovel" testing on a pair of missile fins. Test results, to be released as WADC TR 59-581, "Development of a Reinforced Plastic Sandwich Missile Fin," are typical of routine operations for technicians and engineers at the USAF's Holloman Missile Development Center. It is typical also of projects that can be accomplished only on the Center's new seven-mile-long track.

The test objective—to demonstrate such advantages as may be gained by using reinforced plastics in primary structures under elevated temperatures.

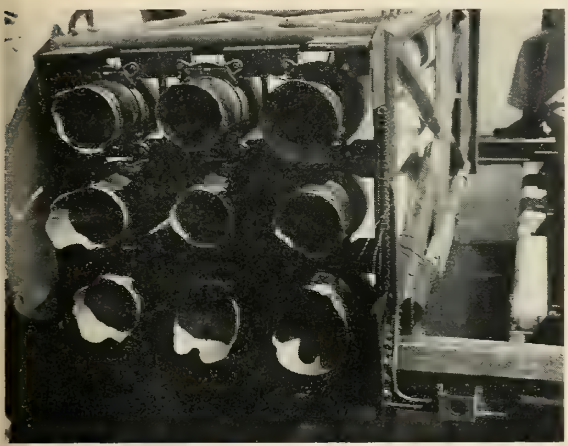
One fin was conventional metal construction with titanium ribs and skins, and forged aluminum ribs—a total weight of 60 lbs. The second fin, constructed and designed by the Research and Development Div., **Narmco Industries, Inc.**, was a full-depth sandwich with Conolon 508 plastic laminate facings, 17-7 PH stainless steel core forward 30%, aluminum core aft 70% and aluminum torque box attachment fittings. Facing to core adhesive was Metlbond 304/1 and facing to attachment fitting adhesive was Metlbond 4041. Total unit weight was 42.8 lbs.

The tests were conducted with an AFMDC sled designed and built by **Coleman Engineering Co.** Power was nine 30,000-lb.-thrust **Grand Central Rocket Co.** *Javelin* units.

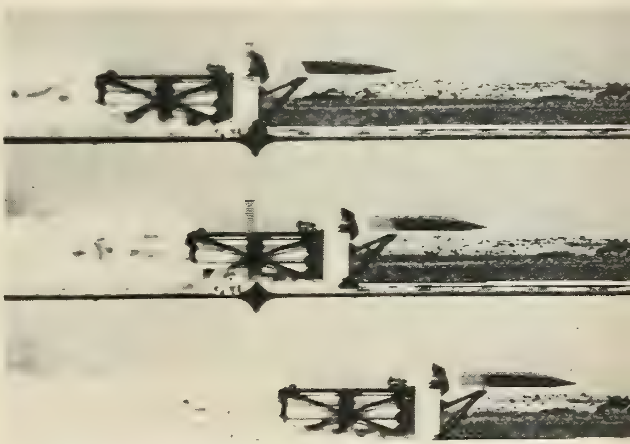
PLASTIC FIN is at left, titanium at right. Fins were mounted as fixed units on pylon at a negative angle of attack of –4.82°. Both units were painted black for high uniform thermal absorptivity.

PRIOR TO run start, each fin was heated to approximately 600°F by GE-T3 quartz heating lamps to simulate aerodynamic heating since such heating would not occur during short duration of test. Lamp reflectors, originally used in fin static tests, were modified by Narmco, which also designed reflector carriages and withdrawal track to pull heater panels back prior to sled start. Lamps were re-spaced in reflectors for correct maximum temperature distribution with constant power input to eliminate complex and elaborate temperature controllers.

SLED AND FINS are re-checked after run. Test program included highest thrust operation (about 270,000 lbs.) ever attempted at Holloman track. Titanium fin (right) shows some indication of high loads. No material was ablated from either fin. Velocity of sled was approximately 2400 ft. per sec. (1636 smph). Vehicle weighed 6500 lbs. and required a run of 27,000 ft. AFMC sled was designed and built by Coleman Engineering Co. Power is nine 30,000-lb. thrust Grand Central *Javelin* rockets.



NOZZLE END of Grand Central *Javelin* rockets after Narmco fin test. Note nozzle erosion towards center of cluster in "hot spot" areas.



HIGH-SPEED camera shot of sled start and run. Test of fin materials is typical of projects that can be accomplished on seven-mile track.

THESE RACKS were used to hold quart lamp heaters (which simulated aerodynamic heating) at the start of the sled's run.

THIS PRIMARY TOWER in "boresight range" is one of two tall structures at Ryan's newly opened facility which are important in microwave study. Transmitting tower stands on a concrete base 15 ft. above ground with about 38 ft. underground.

astrionics

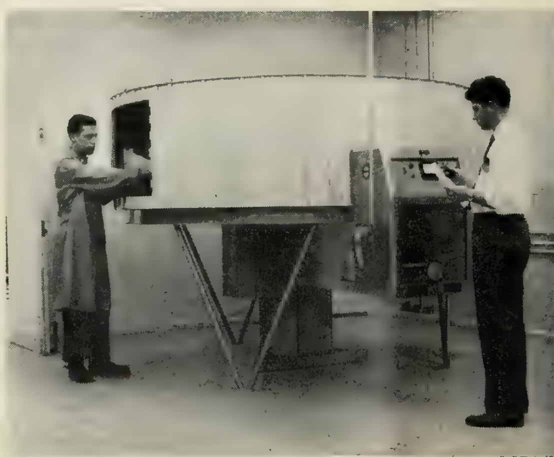
Ryan Opens Versatile New Resear

SAN DIEGO—What may be one of the missile industry's most complete and best equipped laboratories for research and development of electronic components has been opened by **Ryan Electronics.**

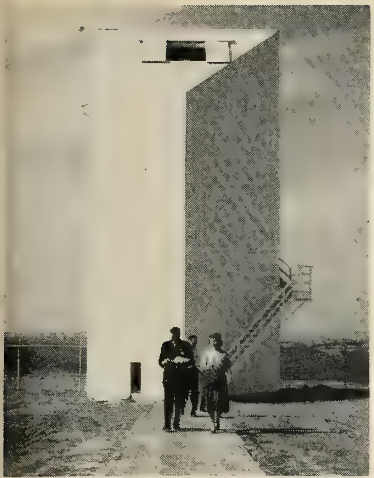
The facilities are housed in a two-story, 28,000-square-foot building specially designed to function as an electronics laboratory. An Environmental Test Laboratory can simulate altitudes from ambient to 150,000 feet, temperatures from minus 100°F to plus 500°F, humidity from 20% to 95%, shock of 2.2 to 32 milliseconds plus duration and magnitudes from 4.5 to 210 g, centrifugal forces from 0.1 to 175 g, vibration to 5000 force pounds sine wave 5-25000 cps and 4600 pounds rms random 20-2000 cps. complete with oil film slip table for vibrating in a horizontal plane, compression and tension testing up to 20,000 pounds, and salt fog corrosion from ambient to 125°F.

A Microwave Laboratory includes six bays, permitting six different types of testing at the same time. To provide the nearest condition possible to ideal free space for measurement of microwave beams, doors on the bays open onto a balcony facing across the barren flight pattern of Miramar NAS.

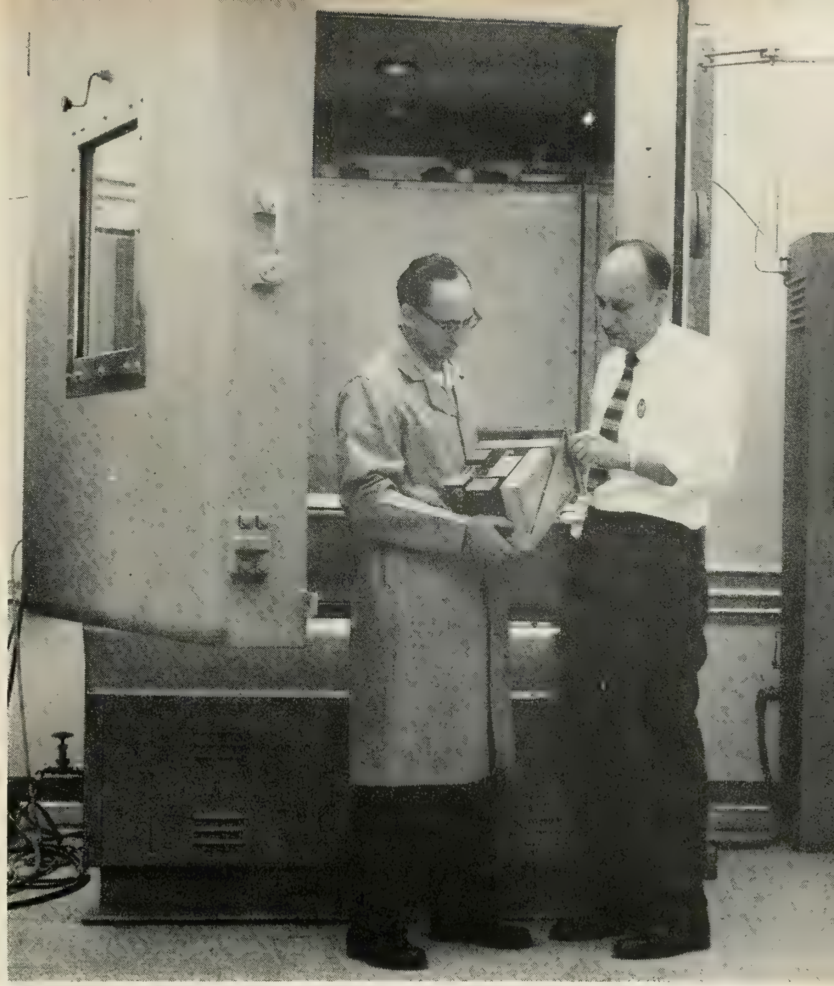
ANTENNA for test on "boresight range" is mounted to huge gimbal (foreground). Gimbal's surface plates are adjustable to provide perfect horizontal reference for boresight mechanism in transmitting tower.



THIS MISSILE centrifuge can apply as much as 175-g force to test reliability of electronic components. Left, Warren Rinehart, lab technician, and Robert Inabinette, environmental test engineer.



SECONDARY tower has antenna dish to return transmitter tower's signal. Odd building design prevents signal bounce back from surfaces other than dish.



WIDE RANGE OF temperature, altitude and humidity can be provided in this environmental chamber. Russell Holmes, left, technican, and Grant Hubbell, supervisor, prepare component for test.

acilities

A Boresight Tower Range has been designed to permit boresighting of antenna beam angles to within one minute of arc. The range has a primary and secondary tower. Each tower is about 38 ft. above ground, but the height is adjusted to sea level rather than ground level to provide a true horizontal for antenna beam axes. The facility will be used extensively for doppler navigation research.

VIBRATIONS which could damage or destroy missile parts can be simulated on Ryan's new vibration exciter. R. V. Peters uses strobe light. Stanley Ave monitors control console.

IRREGULAR SHAPE of wall and ceiling helps reduce noise in vibration test facility. Acoustical materials bring sound level down from 120 decibels at source to 45 decibels, equal to a radio's hum.

GT&E Ups R&D

$20 Billion Annually Seen in Next 8 Years

NEW YORK—**General Telephone & Electronics Corp.**, taking a major step to assure that its divisions and subsidiaries keep abreast of technological progress, has formed the **General Telephone & Electronics Laboratories, Inc.**, a wholly-owned subsidiary to be engaged solely in scientific research activities in the communications and electronics field.

The new research facility will be based around the Bayside, N.Y. Research Laboratories of **Sylvania Electric Products, Inc.**, a GT&E subsidiary. Additional facilities will be added later, according to Donald C. Power, chairman and executive officer of GT&E.

Power said the laboratory will be responsible for basic research and advanced development in major technical fields of broad interest to the current operations of GT&E, as well as exploration of new technical fields having potential interest to the company.

The 50-acre installation at Bayside employs about 350 persons engaged in physical electronics, chemistry, solid-state physics, metallurgy, and systems and circuits research. Specific projects include work on new principles of data processing and display, communications, lighting, television and radio, power transmission, semiconductor devices and electron tubes and related projects.

Dr. Herbert Trotter, Jr., senior vice president-research and engineering for Sylvania, will head the new subsidiary with offices at the General Telephone Building in New York. He will also coordinate the research engineering activities of the Sylvania, **Automatic Electric Co., Leich Electric Co., Lenkurt Electric Co., Inc.**, all manufacturing subisidaries of GT&E.

The new subsidiary is partly the result of a study by Lt. Gen. James D. O'Connell, retired Chief Signal Officer of the U.S. Army, who has been consultant to the company since July. He will now act as a vice president of the laboratories. Other officers include Dr. Robert M. Bowie, vice president and general manager; Dr. Bennett S. Ellefson, vice president-finance; Ralph D. Heusel, treasurer; and H. H. Howlett, secretary.

Predicting a $20 billion annual expenditure for research and development by industry, government, universities and private laboratories in the next seven or eight years, Power emphasized the necessity of industry to gear its long-range planning to research and development on a broad scale.

1 Ton in *Titan*

Magnesium Usage Growing in Missiles

MIDLAND, MICH.—A ton of magnesium-thorium sheet and extrusions is used in current models of the *Titan* ICBM, according to **Dow Chemical Co.**

This is one of the newest uses for magnesium, one of the lightest metals, as a missile structural material. Two-fifths of the *Titan* skin structure, in addition to external conduits and internal structure, is magnesium-thorium alloy.

Earlier ballistic missile uses of magnesium alloys include a skirt structure between the propellant tanks and nose cone of the *Jupiter* IRBM, and skin and internal structure of the *Vanguard* launching vehicle. Eight *Vanguard* and *Discoverer* satellites, constructed primarily of magnesium alloys, have been placed in orbit.

More than 600 lbs. of magnesium alloys are used for skins, fairings and internal structure of the *Discoverer* vehicle. Cast and wrought magnesium alloys are used for several re-entry vehicles covered by ablative material and for housings of missile electronic equipment, such as the Arma inertial guidance system for ICBM's.

Subsonic missiles such as the *Snark* and *Mace* use magnesium sheet for fuselage skins. The *Falcon* uses magnesium sheet, extrusions, forgings and castings for skins, internal structure and fins. The *Nike-Hercules, Talos, Bomarc, Terrier* and *Tartar* use magnesium cast and wrought alloys.

Designers select magnesium alloys for weight saving, thermal properties and simplified construction. Low density (average .065 lb./cu. in.) permits use of thicker gauges at less weight than other structural materials. This increases stiffness and buckling strength, reducing the need for complex stiffeners. The strength of magnesium-thorium alloys makes possible their use at temperatures up to 800°F.

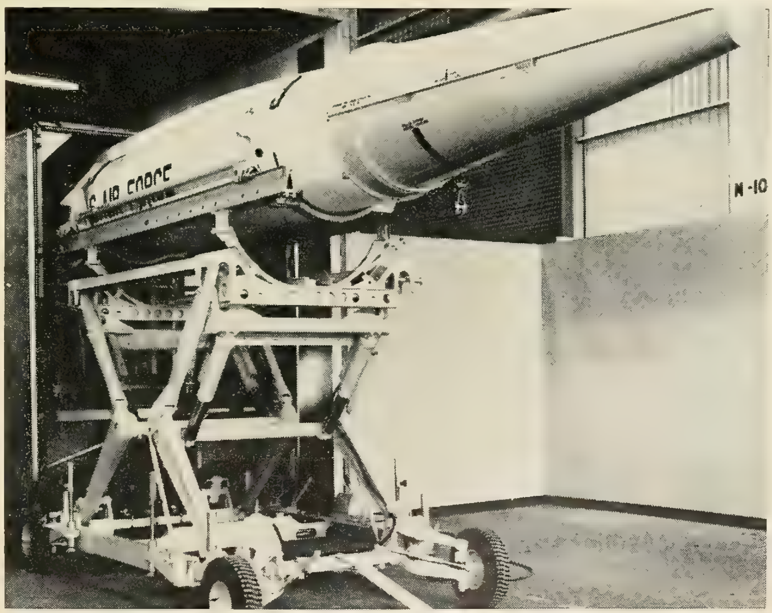
High specific heat values over a wide temperature range permit magnesium-thorium alloy skin structures to operate at lower temperatures than equal weight structures of other metals subject to short-time heating. This can reduce the weight of equipment needed for cooling internal areas and also can reduce thermal shock problems.

Fabrication techniques are well established for magnesium-thorium alloys. Both tungsten arc and consumable electrode arc welding, with inert gas shielding, permit attainment of weld strength efficiencies of 80-90% at room temperature and considerably higher at elevated temperatures.

JPL Adds to Edwards Facilities

THIS 1000-foot-long tunnel system, housing hundreds of connections that assist in measuring temperatures, vibrations, thrust, and other data of rockets as they are test-fired, is part of an expansion program at California Institute of Technology Jet Propulsion Laboratory's test station at Edwards Air Force Base, Calif. The bulk of the pioneering rocket research facility's work is now being performed under contract to the National Aeronautics and Space Administration.

Truck Vans for Bomarc



NEW METHOD of transporting *Bomarc* IM-99B's by motor truck vans—instead of air delivery as in the case of *Bomarc A*—has been developed by Air Logistics Corp., manufacturers of its handling and tie-down equipment. The Boeing missile will be delivered, two to a standard van, partially dismantled for loading. There are 14 *Bomarc* bases planned for North American Air Defense Command, although the McGuire AFB is the only one operational.

Ceramic Cutting Material

The Soviet technical journal *Tsvetnyye metally* (No. 11, 1959), reports that the Russian All-Union Scientific Research Institute of Hard Alloys has discovered the following high-temperature properties of an alumina-base ceramic material used for cutting tools:

• The bend strength decreases very slowly from 33 kg/mm² at 20°C to 29 kg/mm² at 800°C, but decreases more rapidly at higher temperatures—to 14 kg/mm² at 1200°C.

• The Vickers hardness test under 1-kg load revealed that the material remains brittle in the whole temperature range of 20°C to 1200°C, and all indentations showed cracks originating in the corners.

• Hardness decreases linearly from 1800-1900 H_v at 20°C to 350 H_v at 1100°C, but cracks did not form during micro-hardness tests under 100-g loads and hardness values were 100-200 H_v higher.

Organic Tin Polymers

The publication *Vysokomolekulyarnyye soyedineniya* reports that organometallic and organoelemental polymers of silicon, germanium, aluminum and tin are currently receiving considerable attention in the USSR. (Vol. 1, No. 10, 1959.)

The article reports that members of the Scientific Research Institute of Plastics have polymerized methacrylates of alkylated tin. Among the compounds obtained, polymers of triethylstannyl methacrylate displayed high adhesion to glass and metals.

New Astrophysical Lab

According to the Latvian publication *Sovetskaya Latviya*, an astrophysical laboratory has just been built at the Pulkovo Observatory. (Nov. 5, p. 4).

The underground section of the lab is said to contain the world's largest optical tunnel—120 meters—in which a half-meter diameter steel pipe has been installed. Mirrors fastened at the ends of the pipe will reflect rays, and on a six-meter arc, spectra will be formed of light waves of various lengths.

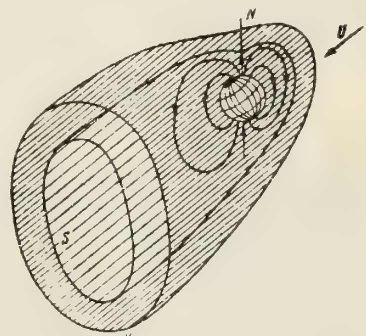
The laboratory will be equipped with a specially designed seven-meter vacuum spectrograph to study the so-called perturbations in the solar atmosphere; a quartz and glass prismatic spectrograph; and an infrared spectrometer for studying the thermal part of the spectrum. Also to be installed is a large electromagnet with alternating telescopic steel tips and a high-temperature vacuum electric furnace.

The article quotes Prof. O. A. Mel'nikov, head of the Observatory's division of stellar physics, as stating that the use of the various machines, pumps, and compressors will create an artificial low-pressure atmosphere in the laboratory which will make it possible to conduct solar spectral research under "natural" conditions. A television telescope connected to the laboratory by a special cable will also be installed.

Aurora Explanation Given

A possible explanation for the aurora borealis has been revealed by Russian scientists studying problems connected with the orbital progress of the Earth through plasma.

Particular attention was paid to the interaction of the ionized plasma streams and the terrestrial magnetic



field. On the basis of previous studies it was assumed that the interaction of the flow of ionized gas with the Earth's magnetic field brings about the appearance of a magnetic "squeeze-out," i.e., the ionized gas in motion flows around a hollow or cavity containing the magnetic field.

Outside this cavity the magnetic field is not present; on the boundary of the cavity the magnetic pressure is balanced by the dynamic gas pressures. Strictly speaking, the boundary of the cavity is a magnetic boundary layer along which electric currents flow. The "squeeze-out" effect is explained by the existence of ponderomotive forces created by these electric currents. Conditions here are considered to be hypersonic since the gas moves around the cavity at a speed higher than Mach 3.

An unperturbed gas flow, after having passed shock wave K (see illustration), flows around surface S. Formulas are given for calculating approximately the pressure of gases on the cavity. The cavity is symmetrical in relation to the Q-plane which passes through the magnetic axis of the Earth running parallel to stream U. Electric currents on the boundary of the cavity S flow approximately in planes parallel to the equatorial in a westerly direction. The order of dimensions of the cavity is related to the value M of the magnetic dipole of the Earth.

The Russians note that the intensity of the magnetic field equals zero at points along the boundary of the cavity S in the neighborhood of its intersection with the Earth's magnetic axis N. The presence of these critical points allows the ionized particles to enter the cavity and diffuse inside it. Thus, they conclude, the aurora borealis may be explained by the unipolar induction occurring when masses of ionized gases enter the cavity and come in contact with the gases moving in the magnetic boundary layer.

Outlined also is a quantitive approach to the problem of finding mathematical expressions for the cavity and the magnetic field inside it. Analytical expressions are given for the force P and momentum L applied to the magnetic dipole as a result of interaction with the plasma.

The article concludes with the thought that this concept is important in plasma aerodynamics since it shows that with the aid of a magnetic dipole it is possible to create remote force loads within a broad range on a moving, conducting medium. *(Doklady Akademii nauk SSR, Vol. 127, No. 5, 1959, pp. 1001-1004.)*

Life on Mars?

The contention that life exists on the planet Mars has been further supported by N. I. Kucherov, well-known Soviet scientist.

He reports that the observed color of the dark spots or "seas" on the planet changes according to the time of the year: blue-green in the spring, brown or grey-brown in the fall. In certain years, the Martian "seas" change in outline and size, thus refuting the conclusion that they are geological formations. Many scientists reason that if the "seas" were tremendous accumulations of mineral salts, changing color according to the humidity, they would have been covered up by dust and sand during the frequent sand storms occurring on Mars. Only relatively tall vegetation could withstand the drifts of sand and

the accumulation of dust.

G. A. Tikhov, Soviet astrophysicist, demonstrated that the spectral curves of the "seas" of Mars coincide with the same curves for Earth plants growing in severe climatic conditions, particularly in the Pamirs and in Tien Shan.

A band in the far infrared range on the 3.4-micron wavelength, inherent in many terrestrial plants, was recently discovered on the Mars spectrum by the American scientist Sinton.

The Soviets plan further study of Mars at the new Planetary Division to be opened at the Pulkovo Observatory. *(Komsomol'skaya pravda, December 13, 1959, p. 6, cols. 1-2.)*

Magnetic Field Research

Data on the intensity of the Earth's magnetic field procured by *Lunik I*, Soviet space rocket, has been released by S. Sh. Dolginov and N. V. Pushkov.

Field intensity was computed theoretically, taking into account the Earth's magnetic dipole and using spherical functions, with graphical representation of results. Real intensity was measured by a magnetometer with a saturation-type transmitter. All three magnetic components at various altitudes were measured.

A comparison of results obtained from measurements and those computed theoretically shows some discrepancies. The difference at a distance of 14.7 x 10^3 km is 300 gamma. With growing distance the difference increases up to 800 gamma at an altitude between 19 x 10^3 and 20.5 x 10^3 km. Maximum negative difference occurs at an altitude of 22 x 10^3, the second most significant difference occurring between 32 x 10^3 and 36 x 10^3 km.

The curve of measured intensities was compared with curves of cosmic radiation intensities obtained by Soviet scientists S. I. Vernox, A. Ye. Chudakov and the U.S. scientist Van Allen. The comparison shows the integral effect of the influence of cosmic radiation on anomalies in the distribution of the magnetic field. The existence of an outer magnetic field caused by electrically changed particles is named. *(Doklady Akademii nauk SSSR, Vol. 129, No. 1, 1959, pp. 77-80.)*

Isotope 'Fire Sale?'

Isotopes will go on sale soon in a shop on Lenin Avenue in Moscow.

Industry and research organizations will be able to procure isotopes at the new store, which will also feature exhibits and instruction in the use of isotopes in industry, medicine and agriculture.

Protective clothing and equipment will also be offered. *(Pravda, Dec. 15, 1959, p. 4, cols. 4-5.)*

reviews

NEW PRINCIPLES IN QUANTUM MECHANICS, H. C. Dudley, Exposition Press N. Y., 155 pp. $5.00.

Doctor Dudley, a Captain in the Navy Medical Service, takes a healthy swipe at the Theory of Relativity, attacks the "wedding of mathematics and philosophy," and bores away at the foundations of what is commonly known as "modern physics."

One of the contentions of the author is that Relativity attained its present exalted position not because of any inherent quality, but simply as a result of the best managed public relations effort the world has ever seen.

There is a collection of most of the early doubters of Lorentz and later theorizes and an excellent bibliography permits the more energetic reader to extend his knowledge of the matter.

The entire purpose of the work is best explained by the author himself when he said it stemmed from an awareness of "the illogical, impossible prediction which result when 'modern' mathematical processes are carried to their ultimate conclusion."

THE MOON AND INTERPLANETARY SPACE FLIGHTS, Summary translation of Izvestiya (USSR). Order AF 1165884 from Photoduplication Service, Publication Board Project, Library of Congress, Washington 25, D.C. $1.80.

The article, popular in its approach, is largely speculative. It is stated that the moon will become a populated world, and that it will be the first station on the road to the conquest of space.

RESULTS OF OBSERVATIONS OF SOVIET ARTIFICIAL EARTH SATELLITES NO. I, SPUTNIK 1958. Order 59-11510 from Office of Technical Services, Department of Commerce, Washington 25, D.C. $.75.

Presented are selected translations of Soviet-bloc International Geophysical Year Literature.

The purpose of the work consisted in determining the orbit of the carrier rocket of the third Soviet artificial earth satellite. The data for the computations consisted of reports sent by Soviet and foreign optical-observation stations to the Astronomical Council of the Academy of Sciences USSR.

GUIDED MISSILE INFORMATION, Order AF 1255956 from Photoduplication Service, Publication Board Project, Library of Congress, Washington 25, D.C. $1.80.

Included are translations of excerpts from open USSR Soviet Bloc and other foreign sources.

AUTOMATIC COMPUTATION AS AN AID TO SCIENTIFIC RESEARCH, Summary technical report, National Bureau of Standards. Order STR-2432 from National Bureau of Standards Office of Technical Information, Washington 25, D.C.

The Bureau reports it has increased the effectiveness of its own scientific program and that of other Government agencies through a computing service.

Problems solved range from calculation of satellite orbits to evaluation of molecular models. The computations are performed on a high-speed computer and frequently aid the development of theory.

FUNDAMENTALS OF GUIDED MISSILES, Aero Publishers Inc. Order from Aero Publishers Inc. Los Angeles 26, California. $12.50.

This profusely illustrated book covering theory, design, operation and maintenance can be used as an introduction for the beginner, but is complete enough to serve as a technical reference for those in the industry. It includes 576 photos and drawings.

The first 46 pages are a glossary of guided missile terms and a short history of guided missiles. The balance of the volume gives comprehensive coverage of guided missile aerodynamics, propulsion systems, physics involved in design, trajectory considerations, control systems and their components, guidance systems and their components, tactics, instrumentation, telemetering, etc.

ENCYCLOPEDIA ON CATHODE-RAY OSCILLOSCOPES AND THEIR USES, John F. Rider and Seymour D. Uslan. John F. Rider Publisher, Inc. New York. $21.95.

The authors have strived to present in one large volume a cross-section of cathode-ray theory, as well as applications in all fields of research where oscilloscopes might be used.

The present book is a revision and expansion of the first edition, published in 1950.

Sections include: "Cathode-Ray Tubes: Theory of Operation and Basic Construction," "Oscilloscope Circuitry and Operation," "Oscilloscope Applications," "Waveform Analysis," and "Commercial Oscilloscopes."

Included in the latter section are specifications and schematics of commercial oscilloscopes.

ADVANCED MAGNETISM AND ELECTROMAGNETISM, edited by Alexander Schure. Order Cat. No. 166-26 from John F. Rider Publisher, Inc. New York, N.Y. 104 pp. $2.25.

This volume in the Electronic Technology Series is devoted to explaining advanced concepts of magnetism and electromagnetism.

It explores various underlying magnetic and electrical phenomena and covers details of the force acting on a charge moving through a magnetic field, induction lines, magnetic flux, Biot's Law, Faraday's Law, Lenz's Law, and the Curie-Weiss Law. Material on the domain theory of magnetism is also presented.

The most modern concepts of magnetism and electromagnetism are explained, together with such items as the cyclotron, the mass spectrograph, and terrestrial magnetism.

Filter Cores Weigh Only 1/3 Ozs.

Acting like tiny telephone operators in space, sub-miniature and micro-miniature filters used to transmit and receive information from missiles and satellites are growing smaller but better.

The Burnell & Co., Inc., pioneers in toroids, filters and related networks, have reduced the size of these sending-and-receiving units. With the help of the **Arnold Engineering Co.,** a subsidiary of **Allegheny Ludlum Steel Corp.,** the special core units in the filters have been reduced from 4¼ lbs. to 1/3 oz. Since there are 23 filters in a complete set or "package," the weight saving alone is tremendous.

Arnold Engineering supplies the powder core, which is the working member of the filter unit. These cores are made of molybdenum permalloy powder compressed under high pressures, annealed and then finished. The filter can transmit and receive information on certain frequencies and filters out other frequencies.

By using certain type filters, a missile or satellite can transmit such information as altitude, pressures, radiation, direction, various gases in the stratosphere or ionosphere and other valuable information. Also, with the filter, changes in direction are made possible.

With such filters as Burnell Company makes, it is possible to receive several messages over the same wire.

In 1947, the telemetering system, which uses 23 filters, and auxiliary equipment weighed a total of 207 lbs. This same type equipment with the sub-miniature units would weigh 11.1 oz.

While it was necessary to get compactness and light weight into the systems, it was vitally necessary to get reliability. All Burnell filters are triple-checked, and must withstand tests to have 100% reliability. The filter units are tested for 100-G's or 100 times the force of gravity and at 2000 cycles per second vibration test. In addition, they are tested for electrical loads. Each unit must withstand ultra high voltage loads far in excess of the load it might be expected to encounter in use.

The unit is hermetically sealed or encapsulated. It is then ready to meet the tests of space.

Circle No. 225 on Subscriber Service Card.

Refractory Material Withstands 6500°F

"Asbestosite," a new refractory material developed for use under extremely high temperature conditions, has been announced by **Harco Laboratories Inc.**

The material is said to withstand continual exposure to temperatures in the 1000°F to 3000°F range and is also capable of being subjected to much higher temperatures during intermittent periods of time.

Tests recently concluded on cylindrical specimen parts with ½" wall thicknesses, indicated a continuous OD temperature of 650°F, while ID temperature readings were a continuous 2500°F. Asbestosite is easily fabricated in a wide variety of shapes and sizes and Harco plans on making the material available in metal-clad configurations.

Strong, rugged and possessing the ability to withstand extreme thermal shock, Asbestosite has stirred interest at Army Ordnance for possible use in heavy tank exhaust systems. Surveys involving the use of Asbestosite in rocket and jet constructions and in cases where materials in a liquid state are to be transferred at extremely high temperatures, are also underway.

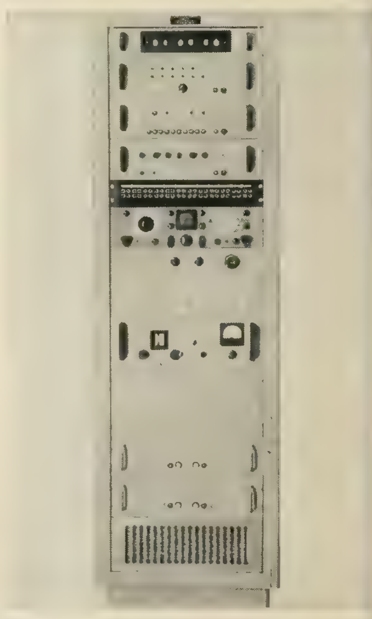
"As a result of the studies we have undertaken, it is obviously clear that Asbestosite materials to be used as tubing, or that may be subjected to heating from within, can definitely be formulated to withstand temperatures above 3000 degrees F. for several hours," reports M. B. Marshall, Harco Vice President and General Manager.

Circle No. 226 on Subscriber Service Card.

Missile Tracking, Control Timing System Available

Hermes Electronics Co. has announced production of a precision timing system for tracking and control of missiles, a binary-to-decimal readout.

This timing system can be incorporated in missile range instrumenta-



tion to provide time references for correlation of events and accurate measurement of missile position and performance.

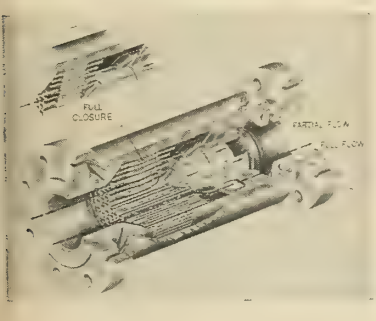
During a missile launching, for example, it is necessary to have accurate information regarding the missile's exact position, the exact time a given event occurs, and knowledge of the time relationships among different events. The new Hermes system fulfills all of these requirements. It is composed basically of a master oscillator which serves as a time base, combined with Hermes' ultratable oscillator (stable to 5 parts in 10 billion per day) with its standard digital frequency dividers and time code generators.

The company's binary-to-decimal converter (model 260) is a new digital product which will translate from any binary language into a decimal readout. It can be used with all computers which process data in a binary code and require an output in the more common decimal code. Semiconductors are used for all conversion and memory functions.

Circle No. 227 on Subscriber Service Card.

Higher Efficiency Claimed For Flexible Silent Valve

Aeration, cavitation, surging, vibration and the resultant noise, all undesirable physical phenomena associated with the rapid flow of fluids, is now virtually eliminated by **Aerojet-General**



Corp.'s new silent valve.

This method of flow control is expected to have wide application in industrial and military fluid systems.

This new principle of flow control was conceived and developed by Aerojet's Anti-Submarine Warfare Division which is managed by Calvin A. Gongwer. S. G. Coon, Jr. is the project engineer. The valve is flexible in size and scope and can be supplied for installation in systems with line sizes from one-inch to many feet in diameter, handling a wide variety of fluids.

The heart of the Silent Valve is a cylindrical plug of elastomer having a

large number of axially aligned holes which serve as flow passages. This plug is contained in a tubular housing between two perforated plates, one of which is either mechanically or hydraulically actuated to compress the elastic insert.

As the plug is compressed, the flow passages are reduced in diameter thereby throttling the fluid flow. At full compression, these channels are closed and complete shut-off is attained. Extremely fine gradations of throttling resistance assure precision flow control over the complete range of operating positions with a minimum pressure loss when the valve is wide open.

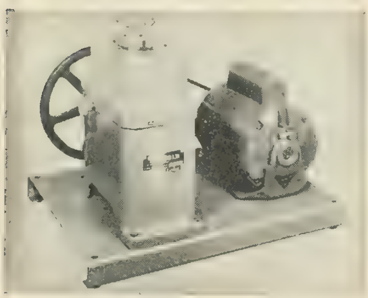
The use of a large number of small-diameter flow passages permits the energy associated with large pressure drops to be dissipated smoothly by fluid friction within the tiny channels. Dynamic underpressures are virtually eliminated from the throttling process. Both cylindrical insert plug and valve body can be made compatible with a variety of fluids including water and petroleum products.

Circle No. 228 on Subscriber Service Card.

German Vacuum Pump Now Available in U.S.

Leybold Rotary Gas Ballast Vacuum Pumps are now being distributed in North America by **Arthur S. LaPine and Co.**

Manufactured in West Germany by **E. Leybold's Nachfolger,** these vacuum pumps are equipped with a gas ballast device that prevents condensation of



vapor in the pump. They have evolved from designs of Gaede, the outstanding figure in modern vacuum pump invention.

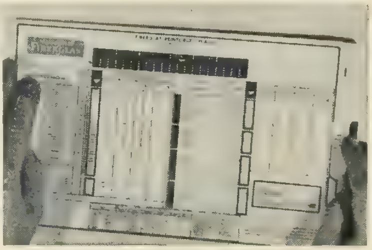
Models available include single-stage pumps that can attain an ultimate vacuum of 2×10^{-3} millimeters of mercury, and the two-stage pumps with an ultimate vacuum of 2×10^{-5} millimeters of mercury.

Both single- and two-stage pumps are available in two sizes: one with a speed of 33 liters per minute, and a larger size with a speed of 100 liters per minute. All are oil-sealed rotary vane vacuum pumps and can be operated with or without gas ballast device.

Circle No. 229 on Subscriber Service Card.

Plastic Comparator Gives Quick Reference Data

A reinforced plastic comparator, known as the Vis-Tec Comparator, has been developed by engineers of **Douglas Aircraft** (who hold the copyright) under the sponsorship of **Owens-Corning Fiberglas.** The materials evaluator condenses many thousands of data units for visual, quick reference for the engineer—an amount which in its original form would be represented by a 2½′ stack of technical information.



The device is in the form of a large slide rule, allowing a design engineer to compare rapidly specific properties of twelve proprietary laminate materials. On the reverse side are charts and tables compiled from military sources and manufacturers' literature, bringing together all the basic design criteria the engineer will need for initial evaluation of various laminate systems.

Circle No. 230 on Subscriber Service Card.

Isotopes Provide Gamma Spectrometry Standards

Calibrated radiation reference sources specifically designed for use as gamma spectrometry standards are available from **Tracerlab, Keleket.** A selection of eight radioisotopes are available, prepared either for use with standard or well-type detectors. These sources may be purchased separately but are most commonly sold in sets of five, each set packaged in a walnut storage case.

The available isotopes have been chosen so as to provide as useful a selection of calibrated photopeaks as possible, considering the practical limitations imposed by 1) availability and 2) unusually short half lives. The isotopes employed are Cadmium 109, Barium 133, Tin 113, Cesium 137, Sodium 22, Manganese 54, Zinc 65, Cobalt 60.

Type R-34 is intended for use with sample holders and changes accepting disc-shaped samples. These sources are sealed in plastic discs 0.94″ diameter x 0.027″ thick. Type R-35 is designed for use with liquid-type well counters. The sources supplied with this set are sealed in plastic cylinders 2″ high and 0.625″ in diameter. All sources contain approximately .01 to .05 micro curies of activity and are calibrated in gammas per minute at a specified photopeak.

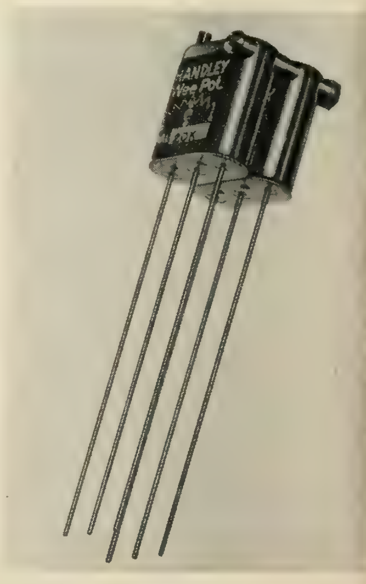
Circle No. 231 on Subscriber Service Card.

Stackable Potentiometer Offers Good Accessibility

A new potentiometer, Model 1W-STK, was announced today by **Handley, Inc.** manufacturers of precision trimming potentiometers. This is a new addition to Handley's Wee Line, and is a stackable trimming pot. Two to ten may be stacked in a row and firmly held together by a steel bolt and nut.

Because of the unusual configuration, placement and length of the leads, lead screw position (on top), this stacking feature offers above-average accessability and compactness.

The 1W-STK precision wire wound trimmer is different in many respects from other potentiometers, combining an unusual configuration, long leads,



and other design features for greater accuracy and extra rugged construction. It withstands 100 g's acceleration, exceeding MIL-R-19; withstands 50g's shock, exceeding NAS 710, Proc. III; and temperature range is from -55°C to 140°C with 1.3 watts at 40C.

Small worm gear adjustment, free of back lash, delivers high-friction loading. 360° wiper maintains its setting under extreme temperature and vibration excursions. It can be sealed to meet MIL-E-5272A. Inductive reactance is so low that it is not measurable at 100 KC, but it may be measurable at 900 KC.

Circle No. 232 on Subscriber Service Card.

Measuring System Gets Smaller Pressure Balance

The Transducer Division of **Consolidated Electrodynamics Corp.,** has introduced a substantially smaller and

lighter Type 4-332 Precision Pressure Balance for use with its Electromanometer precision pressure measuring system.

The transducer portion of the system, which also includes a standard or high-speed servoamplifier assembly, has been reduced in size from a cylinder 5¼" in diameter and 6 3/8" high, to a compact aluminum case measuring only 4 x 3 x 2½". Weight was reduced from 10.7 to 2.6 lb.

Seven pressure ranges are available from 0 - 1½ to 0 - 150 psi differential. Output of the transducer is ±100 volts full scale. Combined effects of linearity and hysteresis are less than .05%.

The transducer can be down ranged to 10% of its rated pressure without loss of accuracy and still provide ±10 volts at this suppressed range. This makes it usable with lower differential pressure, and also enables the instrument to withstand surges at the 10-times-higher pressure (normal full scale) without damage. It also makes possible pressure measurements as low as .15 psid full scale (10% of the unit having the lowest pressure range). The user can make his own modification between the two ranges.

The new transducer employs one force-summing bellows instead of two. The reference pressure (any clean, dry, non-corrosive gas) is admitted to the inside of the aluminum case to surround the bellows being affected by the inlet pressure.

Circle No. 233 on Subscriber Service Card.

Automatic Switch Device Speeds Satellite Data

A compact electronic automatic switching device that will speed information from missiles and satellites to ground installations has been developed by **Electronic Systems Development Corp.,** a subsidiary of **Solar Aircraft Co.**

The corporation has received a contract for an Air Force evaluation of the electronic static commutator.

The miniaturized switching device consists entirely of compact electronic circuits and has no moving parts. It is capable of operating more than 500 times faster than the less reliable mechanical switches it will replace.

For space exploration the static commutator will consecutively open and close 60 different channels between sensing devices in a missile and the missile's radio transmitter. Signals from these sensing devices, measuring such items as pressure, temperature and radioactivity, are sent in sequence through the transmitter and back to a control station on the ground where the data is recorded for study.

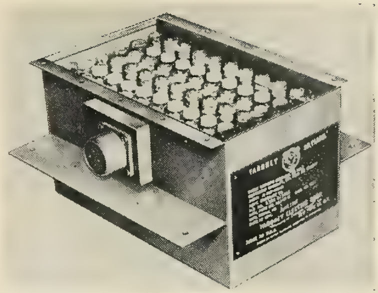
Circle No. 234 on Subscriber Service Card.

New Silvercel Battery For Missiles Announced

Development of the Silvercel Battery 3381R-2 for missile applications has been announced by **Yardney Electric Corp.**

A rechargeable silver-zinc power pack, this 10-amp.-hour unit has a nominal voltage of 28 volts when discharging at 45 amps in 12 minutes. It can also be discharged at 60 amps, or at lower rates. It has a volume of 239 cubic inches and weighs 15 lbs. Its dry shelf life is a minimum of two years.

Designed to meet stringent requirements for missile electric power systems, the new battery has met test specifications of MIL E5272: up to 5 g vibrations; 15 g, 11 milliseconds in all directions mechanical shock; -65°F low



temperature; 160° high temperature; 95% humidity at 160°F; 55,000 feet at 80°F high altitude.

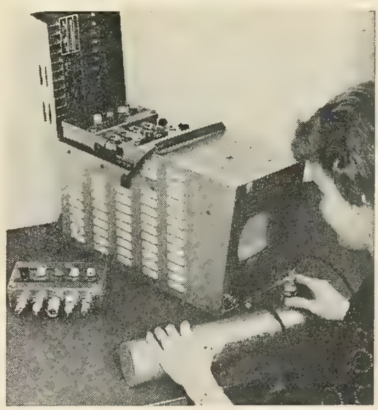
Circle No. 235 on Subscriber Service Card.

Flaw Alarm Devised For Electronic Monitoring

Three new flaw alarms for electronic monitoring are now available as accessories for Sonoray ultrasonic pulse-echo flaw detectors built by **Branson Instruments, Inc.** Test signals which appear within preset limits are detected by the flaw alarm to actuate recorders or warning devices. Also, the alarm signal may be used to initiate corrective action automatically.

A flaw alarm lets the operator pay closer attention to materials under test, instead of constantly having to watch the cathode-ray tube. The Sonoray screen is referred to only when evaluating defects noted by the alarm.

Each new flaw alarm has a single



time gate which is adjustable for position, length, and duration. The alarm may be turned on or off without disturbing work in progress or changing the settings of the Sonoray.

All three flaw alarms have two outputs in common. The first is a red defect-indicator light mounted on the Sonoray front panel. The other is a 5 v dc (no-load) signal fed through a coaxial connector on the back panel, which will trigger audible alarms or

markers, or start corrective action. It can also be used to actuate a simple go/no-go recorder.

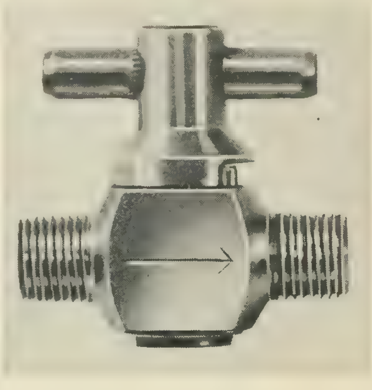
A remote warning light outlet forms part of the indicator light circuit. Remote signals are particularly useful for complex tests requiring the operator's full concentration. For convenience, the remote light can be attached to the test probe itself.

Circle No. 236 on Subscriber Service Card.

Leakproof Valve Uses O-Ring Principle

A miniature leakproof shutoff valve designed for use in vacuum or pressure service is now available from **Circle Seal Products Co., Inc.** The O-ring principle makes the valve leak-proof and easy to operate. The "T" handle is color-coded for gas or liquid service such as oxygen, air, nitrogen, hydraulic fluids, water, oil and many others. Some typical applications include instrumentation, inert gas test stands, hydraulic clamps, and jacks.

The Circle Seal 9500 Series valve features an O-ring on the cylindrical face of the straight plug which prevents leakage past the inlet port as well as the critical stem area. A quick glance at the "T" handle position instantly indicates exact valve position. A quarter turn is all that is required from full open to dead tight close. No spring is



used; no complicated adjustments are necessary.

Repair can be effected without removing valve from the line. O-ring seals are said to virtually eliminate wear. It can be used for metering by turning the handle between full on and off positions.

The 9500 Series valve is available in brass or stainless 303 with either male or female connections in 1/8" or ¼" size.

Circle No. 237 on Subscriber Service Card.

Proportional Counter Detects Thermal Neutrons

A new "Long" type neutron proportional counter for neutron monitoring applications is announced by **The Victoreen Company.**

Designed by Victoreen's Tullamore Laboratories, the Model NC-1 Neutron Proportional Counter detects thermal neutrons by means of a BF3-filled counter.

In fast neutron counting, the instrument is used with either the Model MC-1, a non-directional moderator, or with the Model SMC-1, a shielded directional moderator. Since both moderators are cylindrical in shape, the BF3 counter can be inserted readily. This detector-moderator combination gives the system a relatively flat response over a wide range of neutron energies of from 100 Kev to 5 Mev with the MC-1 unshielded moderator, and from 10 Kev to 5 Mev with the shielded SMC-1 moderator.

The Model NC-1 Neutron Proportional Counter consists of a preamplifier, amplifier-count rate meter, scaler-high voltage supply and thermal neutron detector. The instrument features a pulse-height discriminator circuit to minimize gamma ray response. Since the boron trifluoride detector produces neutron-induced pulses of greater amplitude than those generated by gamma rays, electronic discrimination of pulse heights is very effective. A 10-turn discriminator control is mounted on the amplifier front panel for this purpose.

Cart-mounting of the equipment is suggested for utmost mobility in health physics applications near nuclear reactors and other neutron producing applications.

In experimental applications such as foil transmission of fissionable isotope studies, shielding investigations, etc., the Model NC-1 and moderators can become part of a more permanent laboratory installation.

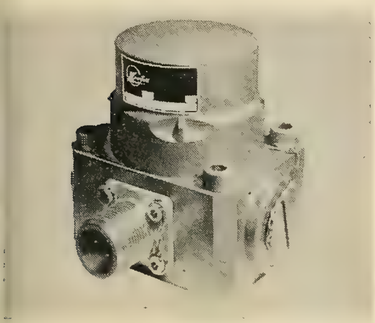
Circle No. 238 on Subscriber Service Card.

Servo Valve Designed For Hydraulic Systems

Kearfott, Inc., a subsidiary of **General Precision Equipment Corp.,** announced the availability of the 6104 electrohydraulic servo valve designed to provide extreme reliability under the most severe environments encountered

in high performance hydraulic systems.

Constructed of titanium, the unit features the exclusive Kearfott development of unity-coupled hydromechanical feedback, which substantially reduces flow force reactions and accomplishes hydraulic centering of pilot position without spring hysteresis and null shift. Springs and mechanical null adjustments Kearfott says, are eliminated completely and high null accuracy is



provided by an electrically operated balancing control. Simply designed to enhance reliability, the valve contains only two moving parts.

The unit is basically a two-stage, four-way flow control valve. An electrical torque motor and "shear seal" orifice hydraulic amplifier constitute the first stage, and an accurately matched spool and sleeve arrangement constitute the second or control stage. The unique feature of the Kearfott design is the hydromechanical unity feedback manner in which the two stages are coupled.

Circle No. 239 on Subscriber Service Card.

New Literature

ALLOY DATA. Two new technical bulletins covering performance data on vacuum induction melted WASPALOY and M-252 superalloys have just been released by Metals Division of the **Kelsey-Hayes Co.** Each bulletin is 8 pages and includes: alloy description and chemical composition, physical constants, tables and charts on mechanical properties, isostress curves, and information on heat treatment and finishing. Both WASPALOY and M-252 are high-temperature, high-stress superalloys produced by the vacuum induction melting process. They are presently being used in missiles, electronic tubes, and process- and nuclear-industry applications.

Circle No. 200 on Subscriber Service Card.

TENSILE TESTORS. A 4-page illustrated booklet, Bulletin T-859, describes a line of tensile-testing machines with capacities up to 40,000 lb. Specifications, descriptions and methods of operation listed for manual and motorized hydraulic models. Procedures for calibrating these units and using them for compression tests are fully covered.

Circle No. 201 on Subscriber Service Card.

CAPACITORS. Four-page data sheets on glass-dielectric wafer capacitors are available from the Electronic Components Department of **Corning Glass Works.** Suited for printed circuit, modular or encapsulated assemblies requiring high reliability, the items are said to be the smallest high stability capacitors currently available. The capacitors are flat. Thus, types without leads can be flat or slot mounted. Because dielectric and conductor layers are sealed together at high temperatures and pressure, they will operate under high heat and humidity environments without further encasing. They meet performance requirements of MIL-C-11272A. Capacitances range from one to 10,000 uuf at 300 DCVW. They have fixed temperature coefficient, high insulation resistance and low dielectric absorption.

Circle No. 202 on Subscriber Service Card.

—when and where—

JANUARY

American Astronautical Society, Sixth Annual Meeting, Statler-Hilton Hotel, New York City, Jan. 18-21.

American Management Association, Special Research and Development Conference, Roosevelt Hotel, New York, Jan. 20-22.

Structure of Strong Normal Shockwaves, Northwestern University, Evanston, Ill., Jan. 21.

Institute of the Aeronautical Sciences, 28th Annual Meeting, Hotel Astor, New York City, Jan. 25-28.

Second Annual Symposium on High Speed Testing sponsored by Plas-Tech Equipment Corp., Somerset Hotel, Boston, Jan. 27.

Research in Rarified Gas Dynamics, Northwestern University, Jan. 28.

Seventh Annual Western Spectroscopy Conference, Asilomar, Pacific Grove, Calif., Jan. 28-29.

American Rocket Society, Solid Propellants Conference, Princeton University, Princeton, N.J., Jan. 28-29.

FEBRUARY

Chemical Institute of Canada, Toronto Section, Symposium on Gas Chromatography, Seaway Hotel, Toronto, Feb. 1.

Instrument Society of America, Houston Section Instrument-Automation Conference & Exhibit, Rice Hotel & Sam Houston Coliseum, Houston, Feb. 1-4.

Sixth Annual Midwest Welding Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology; Chicago Section, American Welding Society, Illinois Tech. Chemistry Bldg., Chicago, Feb. 3-4.

Institute of Radio Engineers, Professional Group on Military Electronics, 1960 Winter Convention on Military Electronics, Biltmore Hotel, Los Angeles, Feb. 3-5.

Seventh Annual Solid-State Circuits Conference, Institute of Radio Engineers, American Institute of Electrical Engineers, University of Pennsylvania, Philadelphia, Feb. 10-12.

Missile Industry Conference (National), Sheraton Park Hotel, Washington, D.C., Feb. 16-17.

First National Symposium on Nondestructive Testing of Aircraft and Missile Components, sponsored by Southwest Section, Society for Nondestructive Testing; Southwest Research Institute, Hilton Hotel, San Antonio, Tex., Feb. 16-18.

AIEE Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia, Feb. 18-19.

—letters—

Asbestos Availability

To the Editor:

Subject: Your 23 November Issue, Page 71.

Any design engineer reading the subject article might naturally assume that "chrysotile asbestos," jewel bearings, and diamond dies are the three most strategic groups of products in short supply today . . .

In order to obtain top level official confirmation of the true situation, I wrote a letter to Mr. H. B. Sharpe, Director of Miscellaneous Metals & Minerals Division of the Business and Defense Services Administration. A photostatic copy of Mr. Sharpe's reply is enclosed. Please note that the national stockpile goal for the purchase of chrysotile asbestos fiber has long since been achieved.

The facts of the situation are these. The present ability of Canadian asbestos mines to provide chrysotile fiber to the U.S. mills far exceeds the consuming capacity of the combined industry. If asbestos textile products are ever again in short supply, it will be occasioned by a temporary lack of adequate manufacturing capacity in this country, not by a shortage of chrysotile asbestos fiber itself . . .

Almost every operational missile today contains one or more parts made from asbestos-phenolic base materials. Asbestos-phenolics are rapidly becoming the most widely used materials to line the combustion chamber of solid-fuel rockets. We certainly do not want to deter design engineers from specifying so useful a material because of a mistaken idea the basic component is in short supply . . .

Mr. J. A. Bettes, Jr.
Manager, Asbestos Textile Division
Raybestos-Manhattan, Inc.

Mr. Sharpe's letter stated in part: "In a recent check of the material it was discovered that a small portion did not meet stockpile specifications. It therefore became necessary to purchase sufficient fibers to replace the non-specification material in order that the stockpile goal be attained." The article in question was necessarily brief and did not elaborate on the situation. Chrysotile asbestos is officially listed by the Office of Civil and Defense Mobilization under "Strategic and Critical Materials for Stockpiling." However, although the government is contracting for a supply for the stockpile, this does not mean it is in short supply throughout the country, a fact which the article may have left unclear. We certainly do not wish to misrepresent the situation.—Ed.

Saturn versus F-1

To the Editor:

Regarding the editorial ("Let the People Know") in the Dec. 28 issue, let me try to help you with the question you pose: *Saturn* is a vehicle. F-1 is an engine.

It so happens that the propulsion system of *Saturn* is in the same thrust class as the F-1.

Therefore, your question "*Saturn* versus F-1" makes little sense. Perhaps you meant to ask why *Saturn* uses a cluster of smaller engines for propulsion system instead of the F-1? This is a sensible question. The answer is well known and has to do with reliability, availability and cost. Besides, the experience will be handy for *Nova,* which is the vehicle to use the clustered F-1 . . .

Harry O. Ruppe
412 McClung Street
Huntsville, Ala.

M/R was comparing the Saturn and the F-1 as boosters, not as entities, and also pointed out the gain of experience in clustering. Otherwise, Reader Ruppe falls into his own word snare. Only the engine for Saturn is available—not Saturn itself. As for reliability and cost—these are debatable factors also.—Ed.

To the Editor:

Regarding your editorial of Dec. 28 as to NASA's reason for both Project *Saturn* and the F-1, as a government Quality Control Representative at Rocketdyne, I feel that you have been misinformed as to the status of the two programs. You state that both boosters will materialize at the same time. This doesn't seem possible when the engines of one booster have completed R&D testing and reliability testing and are now in production, while the other booster is still in the development stage. In addition to lack of funds, slipping in the *Saturn* program may be caused by the second stage *Titan.*

Gordon Drake
10125 Sunland Blvd.,
Sunland, Calif.

Credit Arguello Engineers

To the Editor:

We have noted with interest the article (M/R, Dec. 28) on the Point Arguello facilities for the Pacific Missile Range. The treatment of the data was extensive and the article was quite informative. We hesitate to add what might be considered a discordant note, but it strikes us that there is little, if any, mention of the engineers who strive to bring these facilities into being.

Perhaps you intend to bring attention to this aspect in other articles. Engineers are prone to let their "works" speak for themselves. Accordingly, they go unsung more often than not. I consider that the engineers concerned, however, should merit recognition even if only by an occasional mention. You will, I am sure, recognize that this is only asking for their due.

P. Corradi
Captain, CEC, USN
Deputy Chief of Bureau
of Yards and Docks
Washington, D.C.

missile business . . .

By WILLIAM E. HOWARD

Congress is setting up what amounts to a unified complaint department to handle criticism of DOD procurement and supply procedures. A new procurement subcommittee of the Joint Economic Committee will assume this function when it opens public hearings on Jan. 28.

Among the first critics to be heard . . .

will be Sen. Jacob Javits (R-N.Y.) who is protesting the concentration of defense contracts in California. Javits is backing legislation to beef up New York's dwindling share of DOD work.

Committee Chairman Paul Douglas (D-Ill.) is expected to revive his long-standing complaints about loose purchasing procedures turned up periodically by the Government Accounting Office. Douglas says the upcoming inquiry will shy away from questions involving military strategy and weapons and deal mostly with budgetary and economic issues.

In the financial limelight . . .

Atlantic Research Corp., Alexandria, Va., reveals that it has sold 25,000 shares of its common stock to the **Axe Science and Electronics Fund** for $1 million. This is about $5 per share under the current (over-the-counter) market price. ARC, founded on a shoestring about 10 years ago, is now a $10 million-a-year enterprise in the rocket propulsion field. In the past four months it has bought up four smaller companies in the Washington area.

The Marquardt Corp. stock has just been listed . . .

for trading on the New York Stock Exchange. The big ramjet engine producer has 1.3 million shares outstanding.

Look for a pick up in General Dynamics Corp. earnings...

This is the word from company president Frank Pace, Jr., who says G-D is on "the threshold of a growth potential that we have not had in the past."

Pace won't predict exactly how much earnings will rise in the 1960's. But he says they will reflect reduced expendtiures on R&D—particularly for the Convair 880 and 600 transports which are already largely written off. The Convair Division of G-D, incidentally, has just revealed it paid out more than one half billion dollars in wages during 1959. The breakdown: San Diego—$271 million; Fort Worth—$137 million, and Pomona—$39 million. Convair expects employment to drop from 40,900 at San Diego to 36,000 this year and from 18,500 to 16,000 at Fort Worth. Ponoma will remain at 6000.

Latest prediction for a record-breaking year . . .

in the electronics industry comes from the Business and Defense Services Administration. The 1960 forecast: $10 billion. BSDA says the military electronics share of this total—up 17% in 1959—"should continue upward in 1960 at the rate of better than 15%."

IBM has established a missile/aircraft marketing . . .

and service district for Southern California. The company's new setup consists of offices at Burbank, Inglewood, Westchester and San Diego, Calif., and Phoenix, Ariz.

Space Technology Laboratories is moving into a 40-acre complex of eight buildings at El Segundo, Calif.

The Air Force is getting ready to build . . .

a $6.6-million laboratory at Wright Air Development Division, Dayton, Ohio, to determine sonic fatigue rates of large structural components of missiles and aircraft. System will utilize 25 sirens run by a 40,000 hp electric motor. Bids are expected to be let next fall.

propulsion engineering . . .

By JAY HOLMES

Ladish Co. has patented D6 steel . . .

after 14 years of company secrecy. The die steel contains about 1% molybdenum, 1% chromium, ½% nickel, ¾% manganese and traces of carbon, phosphorus, sulfur and silicon. Ladish kept the formula secret to prevent competitors from using the steel for forging dies.

Now, however, D6 is in wide use as a material for rocket cases. **Allison Division** of **General Motors, Solar Aircraft** and **Pratt & Whitney** all are making development first-stage 65" *Minuteman* cases of D6. Allison is using it on the 44" second stage and Solar is using it for the 38" third stage.

Ladish claims D6 can be heat treated to practical use as a rocket case material up to more than 250,000 psi for a 0.2% elongation when consumable vacuum arc melted.

Metallurgical test facilities . . .

and personnel have been increased at **Thiokol's** Utah development center. The company wants to exercise closer control and supervision over rocket case manufacturing, now that *Minuteman* is getting closer to production.

Electron beam welding is a process that interests Thiokol metallurgists. Tests of the technique are planned with all major missile metals, to see whether the process can completely eliminate weld weakness. If so, Thiokol is toying with the idea of electron-beam welding cases on the long seam to avoid the cost of forged rings or spinning processes.

Differing specifications . . .

for essentially the same metal are causing headaches among metal suppliers. One supplier has been given 100 steel specifications for common steels. Every missile metallurgist has his own specification for AISI 4340; there are almost as many for AISI 4140.

Some in industry think this is a terrific waste. They say that Germany fought World War II with five steels. Designers specified metal properties instead of composition. It was up to the supplier to provide a metal that would meet the specifications.

Their argument is that this is just one more area where inefficient practices run the cost of missiles far out of proportion. It also adds to the amount of study suppliers must make in bidding on metal subcontracts—which the government of course pays for in the end.

The sheer number of suppliers bidding on a given job is another factor. One shop recently quoted prices on a forging to 27 different companies—and then didn't get the job. The reason for this is the number of possible suppliers increases geometrically as the degree of subcontracting is increased. A prime may ask bids of three or more propulsion companies on a solid-propellant job. Each of these may ask bids from a dozen casemakers. And each of the casemakers goes to several metal suppliers.

Thus the supplier at the end of the line spends half of his time bidding on jobs he never expects to get. He doesn't dare refuse, lest he offend the potential customer, who may come up with a job next month that he has a good chance of winning.

Quoting would be simple . . .

if everyone's specifications were exactly the same. Figure it once and then quote the same price to everyone. But by the time they come down to the metal supplier, the specifications aren't exactly the same. Each fellow in the middle wants to put his own trademark on the job.

More Big Missile Firms Likely to Merge

by G. V. E. Thompson

LONDON—Britain's major missile companies are expected to complete a series of mergers under pressure from the U.K. government, which has repeatedly emphasized its view that there is room for only two or three firms in the nation's missile/aircraft industry.

Because it controls spending by both the military and the nationalised air lines, the government can ensure that its desires are followed.

Last week, **Vickers Armstrong, English Electric** and **Bristol** announced they will amalgamate their aircraft and missile divisions. English Electric and Vickers Armstrong will each hold 40% of the shares, and Bristol Aeroplane Co., Ltd., 20%.

One of the firms expected to remain after the wave of mergers is the **Hawker Siddeley** group. Earlier in 1959, Hawker Siddeley swallowed up **Folland Aircraft**; within the past month, it has made share exchange offers for both the **Blackburn** group and **de Havilland.** Both the latter offers are likely to be accepted.

Blackburn capital was valued at over $10 million, and in this case the offer was an issue of 2,750,000 Ordinary Hawker Siddeley shares. To de Havilland, the Hawker Siddeley group offered one of its Ordinary for each de Havilland Ordinary, and three Hawker Siddeley 5½% Preference plus $2.80 in cash for every four de Havilland 5¼% Preference, which is considered generous (last year de Havilland made a loss and paid no dividend).

The Hawker group also is connected with the Bristol engine group (through **Bristol Siddeley**), and with **Fairey** and **Hunting Aircraft** (through **Airco**).

Other mergers are likely to follow; government pressure and the need to measure up to the Hawker group will force this upon the remaining firms.

• **Jodrell's future role uncertain**—It is uncertain whether Jodrell Bank—at present the world's largest radio telescope—will be kept available for satellite and space probe tracking after it is completely paid for.

Prof. A. B. Lovell, who is in charge of the telescope, has made no secret of the fact that he regards such tracking as an intrusion upon the regular work of his department. This is despite the fact that the owners of the telescope (Manchester University) have taken payments from U.S. organizations for the tracking work, in an effort to raise money to pay for the capital cost of the telescope. These groups, and other users, have been required to contribute to the capital cost as well as to the direct cost of using the facility for their particular project. Contributions paid during December are expected to total $55,000.

Jodrell Bank is still in the red, in spite of these contributions and additional government grants and subscriptions from industry, scientific organizations and individuals amounting to more than $180,000 during the last year. Modifications and construction delays greatly increased the initial cost, and the University has still to find about $170,000 out of the full capital cost of $2.1 million.

Prof. Lovell's attitude comes also despite the prestige which his association with satellite and probe tracking has given him in the eyes of the public. It is an attitude symptomatic of the view too prevalent among top British scientists—that pure science is superior to technology.

So, the Jodrell Bank telescope may or may not be placed at the disposal of space research teams when its capital cost has been raised completely. In any event, still larger telescopes are being built in both the U.S.A. and U.S.S.R.

• **New missile gyro developed**—**De Havilland Propellers Ltd.** have designed a gyro for use where compactness, low weight and reliability are important—as in missile instrument packs. The MG 300 miniature rate gyro is hermetically sealed and consists of rotor, spring and pick-off. Driven by a 24,000 rpm synchronous hysteresis motor, the rotor has a high polar/diametral moment of inertial ratio; the angular momentum is 9.6×10^4g.cm.^{2}/sec. Stiff in all planes, the spring allows rotation about its axis, and the pick-off armature is riveted to its end-plate. Normally energized by 2.4Kc, 80 V (mean) current, the pick-off takes 55mA.

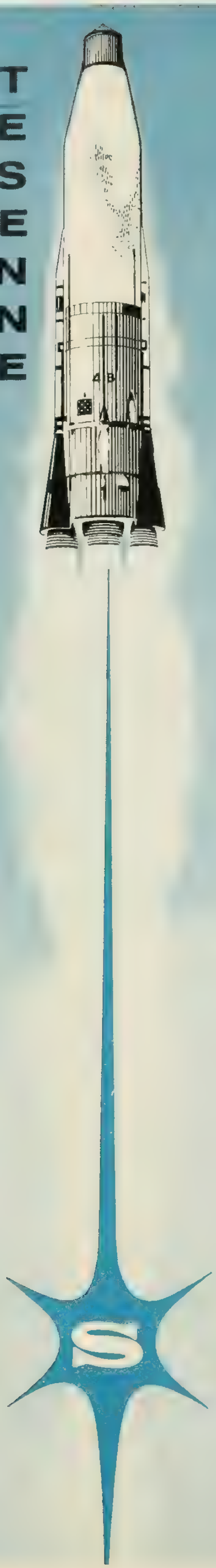
• **Anglo-German joint rocket work**—The U.K. and West German governments have agreed to cooperate in research and manufacture of arms. The agreement, following meetings of Mr. Watkinson and Herr Strauss, defense ministers of the two countries, will include German participation in further development of *Blue Water*, the British ground-to-ground artillery rocket.

Blue Water is designed to be fitted with a nuclear warhead; it will have a range of about 100 miles and a maximum speed of 2000 mph. **English Electric** will manufacture it, but it is apparently still at the drawing board stage. German technicians will thus be associated with its development from an early stage. If it proves successful, both countries are expected to recommend its adoption by NATO.

• **Disquiet over German rearmament**—The opposition Labour Party, meanwhile, is uneasy over the supply to the Bundeswehr of missiles of nuclear capacity. Apart from the future development of *Blue Water*, Germany is to receive several U.S. missiles, including *Nike-Ajax*, *Nike-Hercules*, *Honest John*, *Matador* and *Mace*. The *Sidewinder* and *Hawk* are to be produced jointly by Germany, Belgium, France, Holland and Italy. The *SS.10*, *SS.11* and *Cobra* anti-tank missiles are to be produced jointly by France and Germany. Particular disquiet is being expressed over *Mace*, which would provide the Germans with the means of landing nuclear warheads within 100 miles of Moscow.

• **Woomera developments**—Recent launching of three *Skylark* research rockets within 24 hours was the fastest rate of firing yet achieved. The first rocket was used for sodium vapour experiments at altitudes of more than 40 miles, to yield data on upper atmosphere temperatures and wind structure. The second ejected grenades at regular intervals and also fired metal foil, to give two independent estimates of wind distribution. The third repeated these experiments and also measured electron densities in the ionosphere. All three firings were successful and heights of 90-100 miles were reached.

MOST OF THE ANSWERS MUST BE KNOWN IN ADVANCE



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WRITE TODAY FOR ILLUSTRATED FACILITIES BROCHURE

Neil A. Marshall: appointed chief engineer of Leach Corp.'s special products division, producer of components and systems for air and space vehicles. Was formerly chief engineer of the special products systems department and acting chief engineer of the instruments department.

MARSHALL

Previous position: systems engineer on the *Polaris* project at Lockheed's Missile and Space Division.

A. Clyde Flackbert: named manager of administration for tactical weapon systems operations at Aeronutronic division of Ford Motor Co.

FLACKBERT

Prior to joining the division, was one of three managers at the Airborne Instruments Laboratory division of Cutler - Hammer. Also did system reliability engineering and analysis at The Martin Co., where he was chief engineer for reliability for the *Titan* ICBM, and at American Bosch Arma, where he supervised work on ICBM inertial guidance system.

Alfred A. Crivelle: appointed chief microwave engineer at John Gombos Co., Inc., to lead research and development of microwave components.

Was formerly manager of the microwave section of ACF Industries' Avion division, responsible for design and development of microwave products.

A. M. "Rocky" Rochlen, director of public relations and vice president of Douglas Aircraft Co., retires after 23 years.

ROCHLEN

A veteran newsman prior to joining Douglas, he will continue to be a consultant to the company.

Richard J. Davis, currently Washington public relations representative, becomes director of public relations. Davis joined Douglas in 1958 after 18 years with *Newsweek.*

Howard P. Maginniss, currently assistant to the vice president-public relations, will replace Davis in Washington.

Leslie D. Catlin: named director of management services and **David Y. Keim,** director of engineering, for Stromberg-Carlson's Electronics Division.

Catlin, who joined the company in 1956 as an engineering staff assistant to the general manager, will supervise plant engineering and value engineering activities, and direct organization of a new management engineering section.

Keim will administer design and development engineering work. He joined the firm in March, 1959, as chief engineer of military products in the Electronics division.

Dr. Theodor F. Hueter: elected manager of Minneapolis-Honeywell Regulator Co.'s Seattle Development Laboratory, responsible for work on sonar, underwater ordnance devices and systems, radar and communications.

HUETER

Formerly manager of the acoustics department of Raytheon-Submarine Signal Division, and prior to that, research associate with the physics department of MIT.

Succeeds **Roy A. Malm,** who has left the company.

Dr. J. Robert Downing: named president of Space Recovery Systems, Inc., succeeding **Augustus J. Steinthal,** who will continue as a member of the board of directors.

DOWNING

Dr. Downing earlier served as director of Cook Electric Co.'s research and development division, was responsible for development of recovery systems used in the *Jupiter-C* nose cone, including the one which contained Able and Baker.

Col. Thomas W. Cooke: designated chief of staff, Army Ordnance Missile Command, succeeding **Col. John G. Zierdt.** Col. Zierdt becomes deputy commander, Army Rocket and Guided Missile Agency, in charge of anti-missile and space defense programs including *Nike Zeus.*

Bernhard A. Hohmann: senior staff member and chief, aeromechanical section, *Atlas* weapon system at Space Technology Laboratories, Inc.: appointed project engineer for the *Atlas/Mercury* program.

Before joining STL, Hohmann was chief, flight development section at WADC.

Martin John Timmons and **Merl Watchke:** join the engineering staff of FluiDyne Engineering Corp., assigned to development and instrumentation projects connected with high-altitude simulation chambers, rocket motor test facilities and shock tubes.

The following appointments have also been announced:

Kenneth G. Farrar: named vice president in charge of manufacturing for Douglas Aircraft Co., succeeding **Frederic W. Conant,** who has retired.

Dr. Lloyd T. DeVore: succeeds **Richard A. Maher** as director of engineering at the Laboratories Division of Hoffman Electronics Corp.

Donald A. Bewkes: elected manager of production planning and customer service at Tung-Sol Electric, Inc.

H. William Thomas: formerly manager of the industrial and aviation departments, project development division of Ralph M. Parsons Co., joins the Astronautics Division of Chance Vought Aircraft, Inc., as market development manager.

Charles R. Rowe: named general manager of the newly created West Coast division of Oak Mfg. Co.

Dr. Erwin O. A. Naumann: former chief of advanced studies, elected manager of development in the R&D engineering division at Solar Aircraft Co.

Jackson S. Kolp: former manager of commercial engineering, appointed product line manager-germanium switching transistors for the Semiconductor division of Sylvania Electric Products, Inc.

Lincoln Van Camp: named vice president-production at Wyle Manufacturing Corp.

Forbes Morse: president of Electro-Mec Laboratory, Inc., elected a director of the Waltham Precision Instrument Co.

Alfred Schall, Jr.: formerly with Aerojet-General Corp., elected executive vice president and general manager of The Allegheny Instrument Co.

Dr. Robert W. Cairns: director of research for Hercules Powder Co., named a member of the board of directors.

Dr. Earl A. Weilmuenster: former director of fuels research of the energy division of Olin Mathieson Chemical Corp., joins the technical staff of the United Research Corporation of Menlo Park as assistant manager of propellant development.

contracts

NASA

$47,533—**Ampex Corp.**, Birmingham, Mich., for magnetic tape recording system for Lewis Research Center, Cleveland.

ACF Industries, Inc., Avion Division, received a contract for engineering, laboratory and model shop work associated with printed circuit electronics. Amount not disclosed.

MISCELLANEOUS

$500,000—**Automation Products, Inc.**, for electronic systems engineering and electronic cabling.

NAVY

$1,600,000—**Allen B. DuMont Laboratories, Inc.**, Clifton, N.J., for the production of telemetry equipment and associated test equipment for the *Talos* missile. Subcontract from **Bendix Products Division-Missiles.**

ARMY

$5,816,800—**Western Electric Co.**, for research and development of the *Nike-Hercules.*

$4,552,402—**Douglas Aircraft Co.**, for repair and missile parts for *Nike-Hercules.* (Two contracts.)

$2,491,644—**Sperry Rand Corp.**, Salt Lake City, Utah, for research and development on the *Sergeant* missile system.

$2,350,214—**Raytheon Co.**, Waltham, Mass., for *Hawk* missile field maintenance equipment.

$1,249,500—**RCA**, Moorestown, N.J., for research and development on the down range anti-missile program.

$1,148,263—**Swanson & Youngdale Construction Co.**, Minneapolis, for construction of guided missile assembly building and warehouse at Fairchild AFB.

$500,000—**Chrysler Corp.**, Detroit, for *Jupiter* program.

$314,332—**Machlett Laboratories, Inc.**, Springdale, Conn., for electron tubes.

$239,192—**Raytheon Co.**, Andover, Mass., for replenishment repair parts for *Hawk* missile system.

$118,353—**Nichols-Southern Div., Yuba Consolidated Industries, Inc.**, Baton Rouge, La., for construction of umbilical tower for *Saturn*, Patrick AFB.

$85,480—**Raytheon Co.**, for repair parts for *Hawk* missile system.

$64,887—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Nike-Hercules* launching equipment.

$62,283—**AiResearch Mfg. Co.**, Los Angeles, for *Nike-Hercules* replenishment repair parts.

$44,378—**Research Institute of Temple University**, Philadelphia, for test of aerodynamic heating.

$25,500—**University of Pittsburgh**, for research and development on "Electron Density Distribution in Semi-Conductors".

AIR FORCE

$500,000—**Weston Instruments div. of Daystrom, Inc.**, for bearing distance heading indicators.

$150,008—**Big Three Welding Supply Co.**, Fort Worth, for oxygen.

$102,060—**Marks Oxygen Co., Inc.**, Augusta, Ga., for oxygen.

$100,445—**Johns Hopkins University**, for basic research on "New Particle Interactions and Properties".

$98,957—**Cornell Aeronautical Laboratory, Inc.**, for research entitled "Molecular Interactions at High Temperatures".

$80,000—**North American Aviation, Inc.**, Missile Div., Downey, Calif., for installation, checkout and testing of *GAM-77* ground support equipment.

$73,195—**University of Rochester**, for basic research entitled "Primary Cosmic Radiation and Interaction".

$70,852—**Aerojet-General Corp.**, Azusa, Calif., for research entitled "Ultra-Energy Fuels for Rocket Propulsion".

$57,018—**University of Maryland**, for research entitled "Mathematics of Fluid Dynamics & Elasticity".

$53,766—**University of Syracuse**, for research entitled "Quantum Field Theory & Elementary Particles".

$52,120—**Cornell Aeronautical Laboratory, Inc.**, for research entitled "Nonequilibrium Flows".

$49,958—**Massachusetts Institute of Technology**, for research on "Mechanical Behavior of Metal Composites".

$48,576—**Cornell Aeronautical Laboratory, Inc.**, research in "Boundary Layers in High-Temperature Gas Flows".

$40,049—**Duke University**, for research on "Psychophysiological Mechanisms of Stress".

$39,600—**Boeing Airplane Co.**, Pilotless Aircraft Div., for data in support of *IM992* missile.

$33,980—**University of Pennsylvania**, for research re "Scattering and Polarization of Electrons".

$33,000—**University of California**, for research re "Chemical Kinetics at High Temperatures".

$32,530—**Yale University**, for research re "Mechanical Properties of Intermetallics".

$31,460—**Case Institute of Technology**, for research entitled "Phthalocyanine Polymers".

$29,800—**Northrop Corp.**, Norair Div., for data in support of SM62A missile.

$29,079—**Texas Tech. College**, for research entitled "Kinetics and Mechanism of Coordination Compounds".

A-C Power Produced By Direct Energy Conversion

SAN DIEGO, CALIF.—The direct conversion of heat into alternating current electricity in significant amounts—without use of rotating machinery or dc-ac converter—has been reported by scientists of **General Dynamics Corporation's General Atomic Division.** A high-temperature cesium cell converter was used in the successful experiments which produced sufficient alternating current to illuminate a series of small light bulbs. Frequencies generated were in the range of 100 kc.

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THE MAN-MACHINE INTERFACE ...a broad systems challenge at General Electric's Ordnance Department

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- Hyper-accurate space vehicle trajectory studies

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editorial...

PMR—One Battle We Don't Need

As if the nation's space program weren't weird and wonderful enough, we are now being treated to a new spectacular—the Battle of the Pacific Missile Range. (see p. 11).

It could probably be termed a limited war, contained within the Pentagon and a small West Coast area, and it alternately rages and smoulders between the Air Force and Navy. It would be ridiculous if it weren't for the fact that it is costing the government a lot of money—and could cost much, much more. Also, it demonstrates anew two facts:

• The Department of Defense's frequent delays and failure in clearly defining the roles and missions of the Services;

• The failure of the Services to abide by those rules even when they are laid down. This has been described by one high ranking Defense official as "almost complete lack of discipline among top military officers."

The situation has been detailed in a recent M/R series and in the lead story of this issue. The Senate Space Committee, already investigating the Air Force-Navy struggle over the PMR, will go more deeply into the matter at public hearings within the next few months. It is likely that other congressional committees will also hear PMR witnesses.

The situation at the Pacific Missile Range is roughly this:

The Defense Department has given the Air Force the primary military space mission, including control (and assembly integration) of all military space boosters. To the Navy, DOD gave the mission of operating the Pacific Missile Range.

On the surface this seems simple enough. The Air Force has Vandenberg AFB, with its training, operation and experimental launching pads for various missiles and boosters. Adjacent to Vandenberg, the Navy has Point Arguello, which supplies all basic range facilities. These include the normal tracking along a far-flung downrange course, and the usual supplies and services.

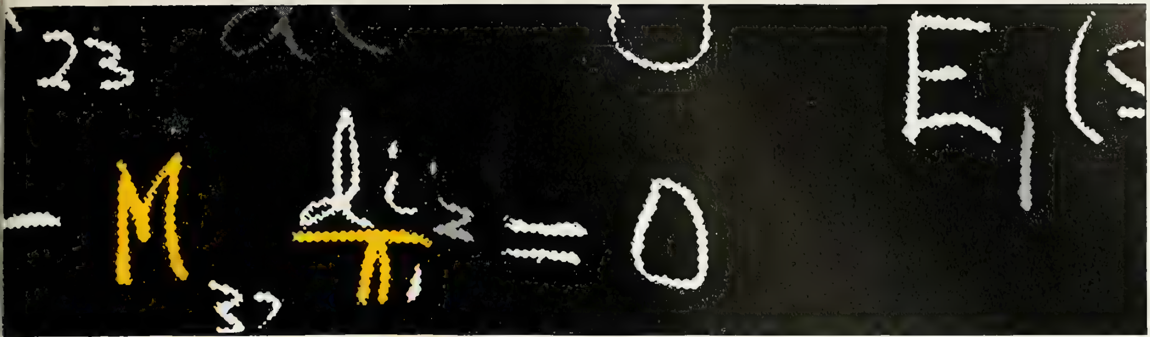
What has evolved, however, is a disgraceful and unpretty squabble between the two services.

The Navy is building two launch pads on Arguello (*Samos* pads for the AF on ARPA orders), and has plans for more. The Navy also has plans for a host of other structures on Point Arguello to eventually turn it into a $4-billion space installation—which the Navy says it needs.

The Air Force is prepared to tell Congress that the facilities the Navy proposes simply duplicate those on Vandenberg, that the Navy is actually setting up a duplicating military space program, and that it has even established a special office in the Pentagon for this purpose—"Ops 54," which is reminescent of the old "Ops 23" of the bitter B-36 fight.

It is not our purpose here to take sides. The Navy may be right—or the Air Force. But if the facts are as they indicate, and there is a vast duplication of effort and money in the Battle of the PMR—then someone must make a decision and impose sufficient discipline to make that decision stick. The Defense Department hasn't been willing or able in the past, so we suspect it will be up to Congress. We would like to see the whole silly affair aired, and the resolution of what seems to be a potentially very expensive situation.

CLARKE NEWLON



JANUA 5, 1960

TITAN PRODUCTION LINE

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

SPECIAL REPORT

Fiscal 1961 Budget—
at It Holds for Missiles and Space . . . 19

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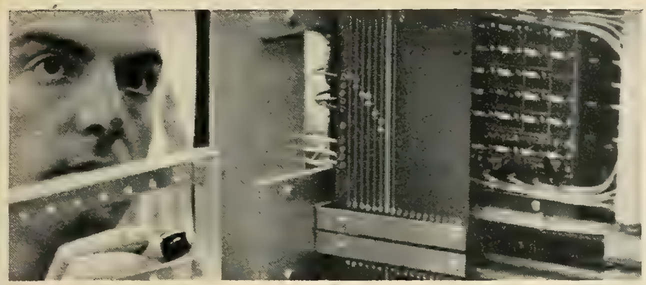

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Missiles and Rockets Volume 6 Number 4

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COVER: First photo of the *Titan* production line at Martin Co.'s Denver Division. Here are first and second stages in various phases of assembly. For a report on new techniques in the assembly line, see p. 32.

COMPARING Northrop Corp.'s space capsule mock-up and his own racing car, driver Jay Chamberlain prepares to test a biomedical instrument system developed by Northrop's Norair Div. to send data from space.

RP-76 target bird sits in front of *Nike-Hercules* missile which will be simulated enemy in Army *Nike* firings. Radioplane Div. of Northrop Corp. recently received a $7.5 million contract for 400 RP-76's.

DESTINED to be a dome for the rocket motor of the *Minuteman* solid-fueled ICBM, a 300-lb. elliptical head is inspected after pack pressing at the Lukens Steel plant, Coatesville, Pa.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

32,200 copies of this issue printed

JANUARY 25 HEADLINES

ASTRONAUTICS ENGINEERING
U.S. Reg. Pdg.

NEW MISSILE PRODUCTS

THE MISSILE WEEK
U.S. Reg. Pdg.

DEPARTMENTS

—when and where—

JANUARY

Institute of the Aeronautical Sciences, 28th Annual Meeting, Hotel Astor, New York City, Jan. 25-28.

Second Annual Symposium on High Speed Testing, sponsored by Plas-Tech Equipment Corp., Somerset Hotel, Boston, Jan. 27.

Gas Dynamics Colloquium, Research in Rarified Gas Dynamics, Northwestern University, Evanston, Ill., Jan. 28.

Seventh Annual Western Spectroscopy Conference, Asilomar, Pacific Grove, Calif., Jan. 28-29.

American Rocket Society, Solid Propellants Conference, Princeton University, Princeton, N.J., Jan. 28-29.

FEBRUARY

Chemical Institute of Canada, Toronto Section, Symposium on Gas Chromatography, Seaway Hotel, Toronto, Ont., Feb. 1.

Instrument Society of America, Houston Section, Instrument-Automation Con-Conferences & Exhibit, Rice Hotel and Sam Houston Coliseum, Houston, Feb. 1-4.

Society of the Plastics Industry, 15th Annual Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Feb. 2-4.

Sixth Annual Midwest Welding Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology; Chicago Section, American Welding Society, Illinois Tech Chemistry Bldg., Chicago, Feb. 3-4.

Institute of Radio Engineers, Professional Group on Military Electronics, 1960 Winter Convention on Military Electronics, Biltmore Hotel, Los Angeles, Feb. 3-5.

Institute of Radio Engineers, American Institute of Electrical Engineers, Seventh Annual Solid-State Circuits Conference, University of Pennsylvania, Philadelphia, Feb. 10-12.

Annual Meeting of American Institute of Mining, Metallurgical and Petroleum Engineers, Sheraton Atlantic Hotel and Statler Hilton Hotel, New York City, Feb. 14-19. **(Metallurgical Society Forum on Navy Problems,** Feb. 15)

Third Annual Missile/Space Industry Conference, National Rocket Club, Sheraton Park Hotel, Wash., D.C., Feb. 16-17. **(Dr. Robert H. Goddard Memorial Dinner,** Feb. 17.)

First National Symposium on Nondestructive Testing of Aircraft and Missile Components, sponsored by Southwest Section, Society for Nondestructive Testing; Southwest Research Institute, Hilton Hotel, San Antonio, Tex., Feb. 16-18.

AIEE Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia, Feb. 18-19.

National Society of Professional Engineers Winter Meeting, Broadview Hotel, Wichita, Kan. Feb. 18-20.

Now in magnesium and aluminum

FOUR DOW PLANTS OFFER AIRCRAFT AND MISSILE MEN WIDE CHOICE OF MAGNESIUM WARES

Coiled sheet, thin wall castings, many other production items are now available from Dow's big rolling mill, foundry and fabrication facilities.

Aircraft and missiles manufacturers on the alert for improved materials and production methods would enjoy a personal tour of the four Dow plants that turn out magnesium products. Next best thing is this quick rundown on the new ways of forming and fabricating magnesium now being practiced in these plants to open up new uses for the lightweight metal . . .

TOOLING PLATE, extra flat, is annealed to eliminate residual stresses.

At the huge Madison, Illinois, rolling mill, for example, they're making magnesium sheet that doesn't require stress relief after welding. This is a major step forward in light metal technology and a boon to manufacturers using magnesium assemblies. Madison has also increased the maximum width of sheet to six feet. Five different sheet alloys, including elevated temperature alloys, are now available either flat or in coils.

To keep abreast of the rapidly increasing demand for precision jigs and fixtures, Madison keeps a close watch on the tolerances of Dow magnesium tooling plate. Typical flatness tolerances, for example, are 0.010 inches in any six feet. This means greater accuracy and less machining for users of Dow tooling plate. Madison is now turning out both magnesium and aluminum extrusions that cover a wide range of sizes: from delicate precision parts to a 30-inch circumscribed circle size—made by Madison's mammoth 13,200 ton extrusion press.

Over in Bay City, Michigan, interesting things are happening, too. At the well-equipped Dow magnesium foundry, largest in the U. S., sand and permanent mold castings of all sizes and shapes are being produced on a volume basis. Complete facilities are maintained for heat treatment, styrene DMI impregnation and chemical treatment. A well-staffed quality control team makes sure that all specifications are met or exceeded, and that the most modern equipment and techniques are fully utilized.

The Bay City foundry casts many complex and difficult designs. Large castings with walls as thin as 0.100 are now being produced. Other useful developments include cast-in tubeless passageways for use as hydraulic lines, special coring techniques for casting enclosed shapes, and new magnesium casting alloys.

DOW FOUNDRY offers production capacity for sand and permanent mold castings of all sizes.

A new die casting plant is now on stream at Bay City. This facility houses the most advanced magnesium die casting equipment, including cold chamber metering units which automatically feed metal to the machines and contribute to unusually high production rates. To assure close alloy composition control on both die casting plant and foundry, a direct reading spectrometer provides frequent and precise analyses of the molten metal. Similarly, X-ray equipment is also available where radiography is needed in quality control.

The Dow fabrication plant, also in Bay City, offers capacity for volume work on magnesium assemblies. Here, too, developmental work on magnesium is constantly in progress. The plant is set up to handle large or small jobs, and plenty of both. Its activities include deep drawing, bending, spinning, stamping, piercing, machining, arc and spot welding, assembly, chemical treatment and painting. This plant has pioneered many "firsts" in magnesium production, such as hot drawing, spot welding and automatic welding.

For more information about Dow's magnesium production facilities, contact the nearest Dow sales office or THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1000CL1-25.

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6RV59

Washington Countdown

IN THE PENTAGON

Nike-Zeus test shots . . .

now are expected about once a month at White Sands Test Range. Meantime, the $137 million in pre-production money that Congress voted for the Western Electric AICBM last year will remain indefinitely in the Administration's cold storage vaults.

• • •

Missiles vs. bombers . . .

The outcome can be read in the FY 1961 budget with authorizations for missiles almost topping those for aircraft. And, under present plans, FY 1961 will see the last of the money to be spent on heavy bombers.

• • •

Operational *Davy Crocketts* . . .

will begin entering the Army's weapon arsenal during the coming fiscal year. The hand-carried missile—a product of the Army's Rock Island Arsenal—carries a fractional-yield nuclear warhead.

> First word of what U.S. defense officials thought might be the Soviet big missile shot into the Pacific broke Jan. 20. The Pentagon said it had "unverified reports" of the possible impact of a Soviet nose cone between the Hawaiian and Gilbert Islands.

Project *Sunrise* . . .

is ARPA's new program aimed at originating and studying new concepts for advanced military weapons including the space weapons of tomorrow. Studies will be directed specifically to areas which ARPA feels "may not now be receiving adequate attention by the scientific community."

• • •

Detailed Breakouts . . .

from the new defense budget show that in FY 1961:

. . . spending for all electronics and communications including everything except equipment inside a missile or vehicle will rise to $1,096,000,000—a $190 million increase.

. . . new obligational authority for all ASW programs will rise to $1,370,800,000—an increase of $95 million.

. . . new obligational authority for ASW R&D will drop to $180,500,000—a $45 million decrease.

. . . new obligational authority for R&D on the Douglas *Sky Bolt* runs about $60 million.

ON CAPITOL HILL

The Smart Money . . .

is that Congress will vote considerably more money for space programs this year. A number of top members of the congressional space committees are reported to be highly irritated with President Eisenhower's so-called "doubled" space budget.

• • •

The military salesman bill . . .

proposed by the Hébert Subcommittee is expected to be approved by the full House Armed Services Committee after brief hearings. Meantime, the Subcommittee will move on to hearings on incentive defense contracts and the release of a sharp report on the weapon system concept of R&D.

AT NASA

At least $50 million . . .

will be added to the budget for the Huntsville *Saturn* team for FY 1961, if the team's expectations are realized. That would push obligations for the big booster in the new fiscal year to about $190 million—still $60 million short of the all-out budget previously sought by *Saturn* advocates.

• • •

Tiros launchings . . .

in 1960 are understood to have been stalled by international politics. The weather satellite is ready for its first test launching whenever the State Department permits.

• • •

The *Echo* balloon flight . . .

Jan. 16 is reported to have soared close to an airliner bound to New York from Paris. The rocket-boosted ascension from Wallops Island was the second in a series to test the payload for a reflecting *Echo* satellite.

AROUND TOWN

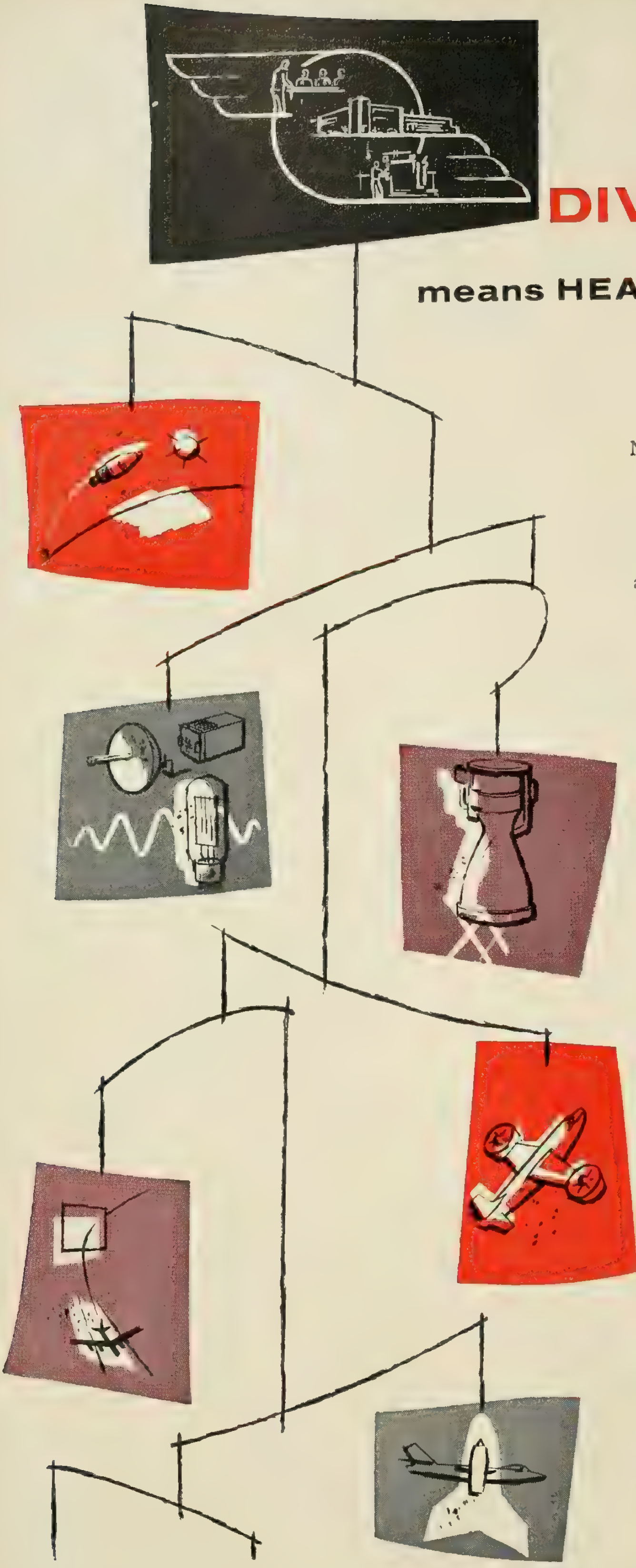
The return of *Lunik III* . . .

to the atmosphere is expected about March 8. The 614-pound satellite that photographed the far side of the moon for the first time was launched last Sept. 18—probably from Mirny.

• • •

The Russian *Golem IV* . . .

an underwater-launched missile of the same class as *Polaris*, is reportedly under development. European sources say that the Russian shipyard at Severodminsk is designing nuclear-powered subs to carry the new missile.



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Industry Countdown

MANUFACTURING

Total of 125 rail-launch . . .
cars are now planned for the Boeing *Minuteman*—probably five to a train. American Machine & Foundry and ACF Industries—winners of the initial $1-million design/development contract—are expected to come up with a prototype late this year. Beyond feasibility stage, contract runs to $6.5-million and also includes design and prototype construction of a railroad launch control car. The feeling now is that the mobility phase of *Minuteman* will be limited. By the time it becomes operational in mid-1963, a "third generation" ICBM is expected to be well along that will be more adoptable to mobile launching—either by rail or ship.

• • •

New *Hawk* anti-aircraft . . .
missile plant costing $50 million is being built at St. Médard, France. Missile assembly will be under management of SETEL (Société Europeené de Téleguidage) composed of Thomson-Houston of France, Telefunken of Germany, Finnmecanica of Italy, Ateliers de Constructions de Charleroi of Belgium, and Phillips of Holland. Rocket engines will be built by SNECMA of France.

• • •

U.S. made components . . .
will go into the first 20 *Nike* and *Hawk* missiles made in Japan. The Japanese plan to make the next 600 themselves in addition to 240 *Bomarcs,* 8000 *Sidewinders* and 400 *Little Johns*—all by 1967.

• • •

France's *Super Veronique* . . .
research rocket now in the test-evaluation stage will carry a 200-lb. payload to 300 miles. Thrust will be 10 to 15 tons, substantially higher than the earlier version which could carry 120 lbs. to 85 miles. Flight tests of 12 *Veroniques* are scheduled in a series of shots at the Colomb Bechar range in North Africa.

• • •

End of *Mace B* . . .
funding is scheduled to come in FY 1961. The new budget has $39.8 million for the Martin surface-to-surface air breather.

PROPULSION

New *Jupiter* IRBM Sustainer . . .
engine S3D has a 245 sec. I_{sp} with a 6000 rpm pump pushing in fuel at 4300 gpm. Dry weight is 1930 lbs., diameter is 5.8 ft. and height is 11.8 ft.

• • •

***Minuteman* 2nd stage sole . . .**
source will be Aerojet-General. Thiokol is now sole source for the first stage. Air Force reluctantly went to sole source on the engines for the solid-fueled missile for budgetary reasons.

• • •

***Mercury* retro rockets . . .**
will fire in sequence or simultaneously at the option of astronaut pilot. Each of the 1000-lb.-thrust rockets is almost spherical, having a length/width ratio of almost 1:1. Burning duration is around 10 sec.

ASTRIONICS

Cryogenic Gyroscope . . .
is being engineered by General Electric under an Army "Project Spin" contract. To be tested this year, the gyro utilizes magnetic fields produced by superconducters to replace mechanical bearings, thus reducing friction and electrical losses to near zero. Near absolute accuracy and reliability is expected as a direct result of dimensional stability induced by near-absolute zero temperatures.

WE HEAR THAT

Lay-offs and hiring . . .
are going on simultaneously at Grumman Aircraft. The company is reducing its aircraft employment by 500 at the same time it is out recruiting shipyard workers to build hydrofoils (it has just boated a $1.5-million contract from the Maritime Administration for an 80-ton hydrofoil ship) . . . Republic Aviation also is laying off about 2000 workers, causing something of a labor surplus on Long Island . . . ICC regulations have been relaxed to permit shipment of liquid hydrogen any distance from the Linde Co.'s Tonowanda, N.Y., plant. Formerly, it was restricted to 500 miles.








Missile/Space Budget: $9.3 Billion

Increase of $2 billion over FY 1960; military gets bulk of money for weapons; Saturn gets overtime boost but other NASA projects starve under one-third spending hike

by Clarke Newlon

The President presented to Congress a national budget request for Fiscal 1961 which included a total of $9.3 billion for missile, rocket and space appropriations. This is an increase of about $2 billion over last year; that increase is largely for weapons. The program (in round figures, millions) breaks down as follows:

All U.S. missile programs	$6,986
Military Astronautics	318
Missile maintenance	1,030
Foreign military assistance missiles (includes support)	276
NASA space program (actual spending)	634
AEC missile and space R&D	54
Total	$9.3 billion

The total missile program figure of $6,986 million was compiled and officially released by the Department of Defense. It divides as follows (in millions):

Missile procurement	$3,825
Missile R&D	1,481
Missile R&D procurement	984
Missile base construction	696
Total	$6,986 million

As a further breakdown of the U.S. missile procurement figure, although it is impossible to obtain exact amounts from the budget, the figure of $3,825 million (quoted by the President) breaks down about like this (in millions):

Procurement of actual missiles	$2,419
Missile support equipment	1,406
Total	$3,825 million

The President noted in his message that the nation's space program would be doubled. Actually it goes in R&D expenditures from $370 million in 1960 to $634 million in 1961. But the 1961 figure includes $139.5 million funded for the *Saturn* program in 1960 by the Department of Defense. This makes the comparative figures $370 million for '60 and $495.5 million for '61—an addition of only $124.5 billion, or one fourth.

NASA's space program for 1961 compared to 1960 is as follows (not including sounding rockets, etc):

	1960	1961
Major deep space probes	3	4
Scientific satellites	7	8

NASA officials at a budget briefing for newsmen said there was no back-up for any of the 12 projects listed above. The back-up, they said, would simply be the next shot.

The 1961 budget includes $4,753 million in new obligational funds for manned aircraft, a reduction of $1,390 million in 1960. This sum will purchase 1,510 aircraft—633 for the USAF, 658 for Navy and 219 for Army, the majority of them missile and rocket equipped. Major purchases in the AF will be for the B-52H, the B-58, the F-105 and the KC-135 tanker. Navy will buy the A3J, the F8U-2n, the F4H and the S2F. Army gets more of the Mohawk, the Caribou and the Chinook helicopter.

• *Hound Dog* **step-up**—One more B-52 wing has been added, making a total of 14 or some 630 bombers. Future purchases will be the H-model. It and the G-model only carry the nuclear-armed *Hound Dog* missile (two each) but others will be modified until every wing is at least partially equipped. *Hound Dog* production by North American will be accelerated.

The budget includes $75 million for the stretched-out North American B-70—enough to produce two prototypes. The B-70 would carry the 1000-mile ballistic, nuclear-armed Douglas *Sky Bolt,* also funded for further study. There is $50 million for a new MATS transport, presumably jet.

The *Atlas-Titan* ICBM program was increased by seven squadrons—13 *Atlas* and 14 *Titan.* This is not a speed-up—simply an addition to the end of program. *Bomarc* procurement will be completed in Fiscal '61, but not procurement of all of its support equipment. Two *Mace-B* squadrons will be sent to the Far East and Europe at a cost of $29 million in the budget.

There is a 50% increase in *Dyna-Soar* funding, continued money for the *X-15.*

Overtime will begin on the clustered *Saturn* booster immediatley, and a supplemental appropriation for it will be requested later in the year. Development work on the *F-1,* Rocketdyne's 1½-million-pound-thrust engine, will continue.

• **Juggling funds**—The President noted that the F-108 interceptor force would have cost $4 billion, and in light of missile development considered it best to drop it; also that the B-70 was competing with four ballistic missile systems— the *Atlas, Titan, Minuteman* and *Polaris*—and thus was stretched out. (Both *Minuteman* and *Polaris* came in for budget increases.)

Of *Nike-Zeus,* the president noted

TOTAL NATIONAL BUDGET

(in billions)

	1959 Actual	1960 Estimate	1961 Estimate
Budget Receipts	$68.3	$78.6	$84.0
Budget Expenditures	80.7	78.4	79.8
Deficit or Surplus	— 12.4	+ .2	+ 4.2

DEFENSE BUDGET

(in billions)

	1959 Actual	1960 Estimate	1961 Estimate
Expenditures	$46.5	$45.6	$45.6
New obligational authority	45.5	44.7	45.3

the difficulties involved in detecting, tracking and hitting an incoming ballistic missile and included funds for further testing—but not for production or facilities. The $137 million appropriated by Congress for initial production steps will not be used, he said.

The President said that he was saving $130 million by suggesting that a new Navy attack carrier be conventionally powered rather than nuclear. The money could be better used elsewhere, he thought. Army's striking power will go up with the purchase of a variety of missiles including the *Sergeant, Honest John, Little John, Lacrosse, Davy Crockett, Hawk* and *Redeye.*

Mr. Eisenhower noted that our $2 billion military assistance gave support to five million army troops, 2,200 combat ships and over 25,000 aircraft (half of them jet) throughout the free world. More than 10% of that $2 billion goes for missiles and missile support.

Military Gets Minimums for Defense

by James Baar

The Eisenhower Administration pushed the nation's luck a year further last week with a new military budget of minimum deterrence for FY 1961.

Increasing missile procurement and missile R&D programs all but dominated the budget which had been frozen at $40.5 billion. But, despite growing warnings from military leaders, the programs continued to stroll—not run.

The new budget includes in direct obligations for missile procurement:

• A boost to $2,941,000,000 for the Air Force—$270 million more than this year. It provides for large purchases of North American air-to-surface *Hound Dogs* and McDonnell *Quail* decoy missiles and funding aimed at increasing the total number of planned Convair *Atlas* and Martin *Titan* squadrons from 20 to 27. But the additional squadrons will be purchased in an extended program. This is *not* a speed-up to meet the Missile Gap.

• A slight drop to $464 million for the Navy—$5 million less than this year. Purchases in a wide variety of missiles, particularly Raytheon *Sparrow III's* and GE-Philco *Sidewinders*. Construction of three more *Polaris*-launching submarines and long lead-time items for three more are included, along with high praise from the President. But the Navy had sought to begin construction of nine.

• A slight drop to $400 million for the Army—$1 million less than this year. Major purchases will include Raytheon *Hawks,* Emerson Electric *Little Johns* and for the first time, production models of two advanced man-carried missiles—the nuclear-warheaded *Davy Crockett* and Convair's surface-to-air *Redeye.* But, although the R&D program for Western Electric's *Nike-Zeus* AICBM is funded at nearly $300 million, the budget doesn't include a dime for producing it.

MISSILE PROCUREMENT

(in millions)

	ARMY		NAVY		AIR FORCE		FOREIGN MILITARY AID		TOTAL	
	'60	'61	'60	'61	'60	'61	'60	'61	'60	'61
New Obligational Authority . . .	399	351	379	450	2,466	3,024	—	—	3,244	3,825
Direct Obligational Authority ...	400	401	469	464	2,671	2,941	168	276	3,708	4,083
Expenditures	472	413	389	397	2,639	2,669	—	—	3,500	3,479

The Administration clearly continued to frown on military space programs. Direct obligations for all military astronautics total $318 million. Requests for new obligational authority in this field were held to $407 million. The bulk of the direct obligations—$249,740,161—is for the Air Force space program which includes the *Discoverer, Samos* and *Midas* satellites.

The Boeing *Dyna-Soar*—the space bomber of the future—received about $50 million. Continued funding at this rate is expected to delay the development of an operational *Dyna-Soar* until about 1969.

• **ASW hiked**—the Navy's ASW programs were boosted 8% to about $250 million. The budget especially noted progress on two new potent ASW weapons—Minneapolis-Honeywell's *Asroc,* which is scheduled to become operational in 1961, and Goodyear's *Subroc,* also nearing a late R&D stage.

The Navy's 1961 shipbuilding and conversion program includes two guided missile frigates, two guided missile destroyers, three nuclear-powered ASW submarines and a conventionally-powered Forrestal Class carrier. However, the Navy's proposals to deploy Lockheed *Polarises* aboard missile cruisers remained buried.

Some $696 million in direct obligations is included in the budget for construction of missile bases and other missile support facilities. Among these are *Atlas* and *Titan* operational launch sites and a start on the first operational sites for Boeing *Minutemen* which are scheduled to become operational about 1963.

RECAPITULATION OF BUDGET AUTHORIZATIONS, OBLIGATIONS, AND EXPENDITURES

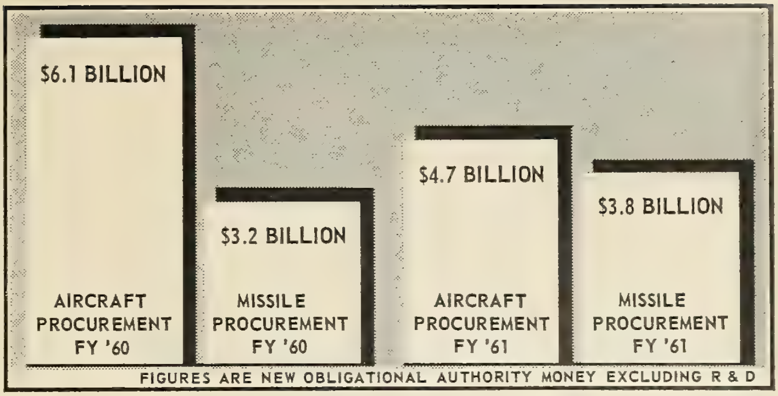
(in millions)

Organizational component	New obligational authority			Direct obligations			Expenditures		
	1959 enacted	1960 estimate	1961 estimate	1959 actual	1960 estimate	1961 estimate	1959 actual	1960 estimate	1961 estimate
Army	$ 9,381	$ 9,679	$ 9,546	$ 9,555	$ 9,966	$10,008	$ 9,468	$ 9,349	$ 9,383
Navy	11,820	11,214	12,013	12,147	11,677	12,139	11,728	11,571	11,683
Air Force	18,713	18,475	17,737	19,599	18,854	18,994	19,084	18,823	18,614
Office of the Secretary of Defense	1,255	1,279	1,281	851	1,182	1,271	953	1,202	1,315
061 Total, military functions	41,168	40,647	40,577	42,151	41,679	42,412	41,233	40,945	40,995
068 Military assistance	1,515	1,300	2,000	2,012	1,748	1,797	2,340	1,800	1,750
Total, Department of Defense—Military	42,683	41,947	42,577	44,163	43,427	44,209	43,573	42,745	42,745

The budget provides a total of $2,334,800,000 for research, development, test and evaluation in missiles, and military sciences as well as military astronautics. This is a $21 million drop from last year.

The biggest slice—$793,200,000 in direct obligations—goes to the Navy, with much of it going into the *Polaris* program. The budget disclosed that the Navy expects to have two *Polaris*-armed submarines on station by the end of 1960.

The Air Force received $684,814,727 in direct obligations for R&D, including some funds for *Sky Bolt,* the Douglas ALBM that is still in the design study stage. The Army received $645,828,000—mainly for *Nike-Zeus,* Martin's *Pershing,* JPL/Sperry's *Sergeant,* Convair's *Mauler* and *Missile A.*



• **Electronic support**—One of the biggest cost increases came in operating and maintaining the nation's expanding electronic network of missile support systems—SAGE, Missile Master and BMEWS. The budget predicted a cost increase of 70% between 1959 and 1961.

Funds are provided in the budget for the BMEWS stations under construction at Clear (Alaska) and Thule (Greenland) as well as a third that will be built in northern Great Britain.

The overall tone of the military budget was one of conservative expansion of some missile programs with a simultaneous contraction of others.

It was set by the expansion of the ICBM program to bring the number of *Atlas* squadrons from nine to 13 and the number of *Titan* squadrons from 11 to 14—not quickly but sometime near the mid-60's.

NASA Boost More Apparent than Real

by C. Paul Means

The $802-million NASA budget sent to Congress last week indicates that the Eisenhower Administration is interested in space, but not in competing with Soviet space accomplishments.

The budget spelled out plans for leisurely space exploration with no back-up vehicles available in case of failure.

Highlight was the $122,750,000 (exclusive of salaries) in new spending authority given the nation's man-in-space effort, Project *Mercury.* In critical financial shape during 1959 (M/R, Jan. 11, p. 30), *Mercury* officials should be helped by the new money to meet their original manned orbital flight date in 1961. Including the $19 million to be asked for in a supplemental FY '60 budget, *Mercury* will now have had $300 million obligated to it.

The 1.5 million-pound-thrust *Saturn* booster, to be transferred from ARPA in the near future, was funded for $140 million as the preliminary ARPA budget had suggested. But the president has asked NASA Administrator T. Keith Glennan to tell him how much more money *Saturn* should have in FY '61. This money, probably about $50 million, will be asked for in a later supplemental budget request.

Of *Saturn's* $140 million, $60 million will be spent in FY '61. Another $34 million has already been obligated for *Saturn* this fiscal year.

• **Carrying** ***Saturn*** **load**—NASA spending during FY '61 will be increased, but not to the "virtual doubling of spending" that the President spoke of in his budget message. FY '61 spending is estimated at $600 million, while $325 million was spent in FY '60. What the President doesn't account for is that $60 million of the FY '61 figure is for *Saturn*—a project not in the NASA budget last year. If all ARPA money spent for *Saturn* in FY '60 is included plus the money ARPA is obligated to spend in FY '61, the comparable figures are $375 million for FY '60 and $634 million for FY '61. And of the $634 million, almost $140 million goes for *Saturn,* a project NASA did not have last year.

The nation's other super booster project, Rocketdyne's single-chamber 1.5-million-pound-thrust *F-1* engine for *Nova,* has been earmarked for $25 million in new obligational authority. This compares with a little over $30 million

NASA APPROPRIATIONS SUMMARY

	FISCAL YEAR 1960 (in thousands)		FISCAL YEAR 1961
	APPROPRIATED	SUPPLEMENTAL ESTIMATES	NEW OBLIGATIONAL AUTH.
Salaries and Expenses	$ 91,400		$167,500
Research and Development	320,350	$ 12,000	545,153
Construction and Equipment	88,825	11,000	89,287
Total New Appropriations	$500,575	$23	$802

NASA EXPENDITURE SUMMARY

	FY '60 (in thousands)	FY '61 (est.)
From NASA funds	$325,000	$600,000
Obligated DOD funds for projects transferred to NASA	45,000	34,000
Total expenditures	$370,000	$634,000

given to the project last fiscal year.

The space administration breaks down its budget to show $545,153,000 going for research and development, $89,287,000 going for construction and equipment, and $167,560,000 for salaries and expenses.

• **R&D breakdown**—In research and development section of the budget, the two largest line items are $107,750,000 for *Mercury* and $81,008,000 for *Saturn*. Lunar and deep space exploration, an area in which NASA has announced it will launch four shots a year, is funded for $45 million, and scientific satellites, which NASA expects to fire at a rate of eight a year, is funded for $41,700,000.

Also of interest in the R&D budget was the $47 million dollars in new obligational authority for *Centaur*, the $40-million-dollar funding of liquid rocket technology, and the $10-million-dollar funding of nuclear systems technology. The latter will be augmented by $26 million in the Atomic Energy Commission's budget.

Only $2,800,000 was provided in new obligational authority for solid rocket technology in FY '61. The space power technology bank received $8 million in added funds.

NASA employes, according to the budget, will take home $167,560,000 in FY '61 in salaries and expenses. Major increase over the $91,400,000 in the FY '60 budget is the $55 million earmarked for the 5500 new NASA employes at the Huntsville ABMA facility.

• **New construction**—Major items of construction and equipment in the FY '61 budget are $18,450,000 for the Huntsville facility, $8 million for two more of the 85-ft., Goldstone type parabolic radio antennas, $15 million for the *Mercury* world wide tracking network, $9.5 million for the new Goddard Flight Research Center near Washington, and $9.1 million for the Lewis Research Laboratories at Cleveland.

The expansion of NASA's space activities is indicated by the decline of aeronautical research in the budget. But NASA plans to devote about 25% of its "in-house" research support to aeronautics. In dollars: about $40 million.

Also mentioned in the President's budget was the $23 million FY '60 supplemental that NASA will ask for in the near future. Some $19 million will go for *Mercury* ($12 million for research and development, and $7 million for construction of the world wide tracking network), and $4 million for construction of *Centaur* facilities at Cape Canaveral.

Other information revealed by the President's budget:

• Project *Mercury's* increased funding should permit the first manned orbital flight in 1961;

• *Centaur* should reach the test stage in 1961;

• Completion of the *Saturn* launching system and an addition to the engineering building at the Atlantic Missile Range are proposed in 1961; and

• No new NASA projects at the Pacific Missile Range are proposed, but launching facilities funded under 1960 appropriations will be finished in 1961.

MAJOR NASA PROJECT'S OBLIGATIONAL AUTHORITY

	FISCAL YEAR 1960 (in thousands)		FISCAL YEAR 1961
	APPROPRIATED	SUPPLEMENTAL ESTIMATES	REGULAR ESTIMATES
Mercury	$ 98,762	19,000	122,750
Nova	30,200	......	25,000
Saturn	70,000	......	140,000
Scout	28,000	......	....
Delta	13,300	......	12,500*
Centaur	37,000	4,000	47,000*

* not including funds for salaries and expenses, funds and equipment.

NASA R&D PROGRAMS—Fiscal Years 1960 and 1961

PROGRAM	FY '60 (in thousands)	FY '61
AERONAUTICAL AND SPACE RESEARCH: (support of NASA plant; research grants and contract JPL plant.)	$ 27,634	$ 61,345
SCIENTIFIC INVESTIGATIONS IN SPACE: (sounding rockets, scientific satellites, lunar and planetary exploration.)	81,624	94,700
SATELLITE APPLICATIONS: (meteorology, communications.)	11,100	26,300
MANNED SPACE FLIGHT: (Project Mercury.)	86,962*	107,750
VEHICLE SYSTEMS TECHNOLOGY	6,737	21,200
SPACE PROPULSION TECHNOLOGY: (solid rockets, liquid rockets, nuclear systems technology, space power technology.)	44,927	60,800
VEHICLE DEVELOPMENT: (Scout, Delta, Vega, Centaur, Saturn.)	57,100	140,508
TRACKING AND DATA ACQUISITION	16,266	32,550
TOTAL PROGRAM	$332,350*	$545,153

*Includes supplemental '60 budget.

RESEARCH, DEVELOPMENT AND EVALUATION

(Direct Obligation)

	ARMY			NAVY			AIR FORCE			ARPA		
	FY '59 actual	FY '60 est.	FY '61 est.	FY '59 actual	FY '60 est.	FY '61 est.	FY '59 actual	FY '60 est.	FY '61 est.	FY '59 actual	FY '60 est.	FY '61 est.
Missiles and Related Equipment	423,184,926	495,507,000	494,798,000	628,266,859	685,520,577	668,500,000	292,014,360	317,293,761	318,257,455	— — —	— — —	— — —
Military Astronautics and Related Equipment	— — —	— — —	— — —	— — —	— — —	1,300,000	221,067,724	296,131,486	249,740,161	103,068,549	111,913,744	67,000,000
Military Sciences	123,320,342	159,107,000	151,030,000	105,534,614	135,116,500	123,400,000	135,193,731	122,483,136	116,817,111	46,632,193	132,340,000	144,000,000
Totals	546,505,268	654,614,000	645,828,000	733,801,473	820,637,077	793,200,000	648,275,815	735,908,383	684,814,727	149,700,742	244,253,744	211,000,000

R&D Funding Contains No Surprises

Missile and space R&D—the basis of America's future in the Missile Age—will receive some $3 billion in direct obligations under President Eisenhower's FY 1961 budget. That is about $150 million more than this year.

Disclosure of the program in the new budget brought no surprises.

Military missiles and related equipment take the biggest share—$1,481,600, a $17-million decrease. NASA comes second with $600 million.

Direct R&D obligations for space in FY 1961, including $318 million for military astronautics and about $175 million for the Air Force *Dyna-Soar* program, are expected to total about $1 billion.

•Launches without backup—NASA aims under its program to launch about four space probes and eight major scientific satellites a year. The military services are planning to launch R&D satellites for reconnaissance, early warning, communications and navigation. The Air Force also plans to launch about one *Discoverer* a month at least for the next year.

However, backup boosters in all programs will be very rare. In the NASA launchings, they will be nonexistent.

The Air Force R&D program for missiles and related equipment totals $318,257,455. This includes funds for the new *Sky Bolt* ALBM, and a number of missiles that are already operational. Additional funds are also included for work on the *X-15* rocket plane and the B-70 Mach 3 bomber which would carry the *Sky Bolt*.

More than $966 million in procurement money actually is for development, test and evaluation of various missiles including the *Atlas, Titan* and *Minuteman*. These programs include work on a *Titan* fueled with a storable propellant.

The Navy R&D program for missiles is $668,500,000. This is primarily for the *Polaris* program. It also provides funds for a number of other programs including *Subroc*. Bendix air-to-air *Eagle*, Temco's air-to-surface *Corvus* and the *Super Talos* anti-missile missile.

The Army R&D program totals $494,798,000. The bulk—nearly $300 million—is for the *Nike-Zeus* AICBM but the program also includes funds for a large number of missiles running from the man-carried *Redeye* to the big *Pershing* which is designed to replace the *Redstone*. Others are the *Mauler, Missile A, Sergeant, Advanced Hawk*.

The new budget provides direct obligations for two small but highly significant programs at the Atomic Energy Commission. One—missile propulsion reactors—receives $40,300,000; the other—satellite power sources—receives $14.4 million. Together they are being increased about $17 million.

TOTAL (In Thousands)		
FY '59 actual	FY '60 est.	FY '61 est.
1,343,500	1,498,800	1,481,600
324,100	408,000	318,000
410,700	549,100	535,200
2,078,300	2,455,900	2,334,800

Surplus Won't Go To Defense

by William E. Howard

Defense contractors can look forward to a fierce Congressional tug of war over President Eisenhower's hoped-for FY 1961 budget surplus of $4.2 billion. But, short of a new Russian threat, the chances are remote that any substantial amounts of this ripe plum will be squeezed into missile/-space programs.

The President is determined to apply every penny of the surplus to reducing the public debt. He can be expected to wield his veto against any and all large new spending programs propounded by the Democratic-controlled Congress.

Moreover, he is equally determined to protect the surplus from any election-year tax cuts.

There is some question, however, whether the $79.8 billion Eisenhower budget actually will be topped by anticipated Treasury receipts of $84 billion when the end of the fiscal year rolls around. For this revenue estimate is based partly on the assumption that Congress will agree to the President's requests for hiking some taxes by a total of almost $1 billion. This includes $100 million from a jet fuel tax and $500 million from a postal increase. That Congress will go along with this notion is extremely unlikely.

• No new weapons—Defense expenditures for the coming year are estimated at $41 billion—about the same as FY 1960. Of the new obligational authority of $40.6 billions, approximately $9.3 billion is sought for missile/space programs. This latter figure is up around $2 billion over the current year—but the extra money is earmarked largely for the Air Force *Atlas, Titan* and *Minuteman* ICBM's and other "going" programs. The budget does not indicate a single new weapon system. Thus new opportunities will be limited largely to R&D.

Actually, there is considerable likelihood this year will see some missile programs cut back in favor of high priority items now in the production stage—like the *Atlas*—which require greater funding as operational weapons. *Jupiter, Thor* and *Lacrosse* have all reached the end of the line in this new budget.

However, the missile support market is being strengthened by the emphasis on operational systems. Air Force support equipment procurement alone is jumping from an estimated $642 million in FY 1960 to $802 million. This is due largely to a corresponding increase from $550 million to $696 million in missile base construction.

• Electronics higher—Electronic demand also will be higher—helped along by NASA's $634 million spending program, an increase of some $300 million over the current year—as well as by greater requirements for missiles.

The legislative program recommended by the President contains some proposals affecting the missile/space industry. An extension of corporate taxes and certain excises will be sought for another year beyond June 30.

Mr. Eisenhower also requests that "consideration" be given to changing the law on depreciation provisions. He said in his budget message that administration of this law is "being hampered by the attempts of some taxpayers to claim excessive depreciation before disposing of their property." He suggests that if the gain from the sale

of depreciable personal property were treated as ordinary income—instead of capital gains—"the advantage gained in claiming excessive depreciation deductions would be materially reduced."

For a third time in as many years, the President asked Congress to repeal a section of the law which requires DOD to obtain the sanction of the House and Senate Armed Services committees to carry out certain types of real estate transactions.

He also renewed an appeal to Congress to eliminate a rider which limits competitive bidding by foreign firms on some military supply items, This rider is worse than the "Buy American Act," he commented.

Private industry would be encouraged to finance, build and operate plants to make more helium available for AEC and missile programs under Administration-backed amendments to the Helium Act introduced last year. The President said they need prompt enactment to check the waste of this essential gas.

To relieve the pressure on the Treasury in borrowing money, Mr. Eisenhower urged removal of the "artificial" 4¼% ceiling on new long-term bond issues. He said this is a major barrier to efficient management of the $290 billion public debt, which he hopes through the application of surplus to reduce to $280 billion by the end of FY 1961.

AEC Gets $700 Million For Missile/Space Support

Over $700 million of the Atomic Energy Commission's $2.450 billion FY '61 budget goes directly to support the nation's missile and rocket programs.

The bulk of this amount, $495 million, goes for nuclear weapons. Though atomic bombs and artillery warheads are included, the greater part of this new obligational authority will go for nuclear missile warheads.

Approximately $200 million supports the military missile program and the military's and NASA's space programs. This goes for propulsion reactors for missile submarines and ships, atomic missile-carrying aircraft, nuclear propulsion systems for missiles and space rockets, and transportable powerplants for generation of electric power and heat in satellites.

A rough breakdown of the AEC Budget shows $14 million going for satellite power sources, $40.3 million for missile and space rocket propulsion reactors, $73 million for aircraft propulsion reactors, $85 million for Navy propulsion reactors, and $15 million for Army propulsion reactors.

Gates Sees Narrower 'Gap'

The Nation's view of the size of the Missile Gap remained cloudy this week after a series of top-level statements and comments from Administration officials, generals and congressmen.

Defense Secretary Thomas S. Gates told the House Military Appropriations Subcommittee that the latest intelligence information revealed that Russian missile superiority will reach a peak about mid-1962.

However, he said that even in mid-1962 if the Russians were to launch a surprise attack with all of their missiles they would not be able to destroy enough of America's retaliatory forces "to make a rational decision to attack."

He said this would be true even if Russia were to manufacture more missiles than presently expected, and those missiles were more accurate than they are expected to be.

However, the rosier picture presented in secret testimony by Gates (and later released in part) was retouched in more somber tones by others:

• Several congressmen who heard the intelligence estimates behind closed doors in the Senate and House said they didn't think the reports led to as optimistic a conclusion as the released testimony implied.

• Sen. Stuart Symington (D-Mo.) said flatly on the Senate floor that President Eisenhower's decision to hold defense spending to $41 billion opened the way for the United States to "become a second class power."

• Gen. Thomas S. Power, commander of SAC, said in New York that unless the United States has adequate warning systems ready in time the Russians could almost wipe out all U.S. retaliatory power in 30 minutes with a total of only 300 ICBM's and IRBM's.

Gates stressed that previous U.S. intelligence estimates were based on the number of ICBM's Russia was capable of producing. He said the latest intelligence estimate is the first on the "probable ICBM inventory and build up time."

He said—without disclosing figures—that the Soviet ICBM buildup both before and after mid-1962 is not much greater than the buildup in the United States.

None of the figures given the committee were released. However, Gates said the new intelligence estimate has narrowed the earlier 3-1 ratio in Russia's favor based on estimates of capability alone.

He also said the accuracy of Russian ICBM's is believed to be inferior to that of U.S. ICBM's.

The Defense Secretary said it is extremely difficult to make a statistical estimate of how much an attack by any specific number of Soviet ICBM's would cripple U.S. retaliatory forces. He cited two prime factors:

• "We do not know exactly what his accuracy is."

• "We do not know exactly how much warning time we are going to have."

Therefore, he said, any comparison of U.S.-Soviet ICBM strength based on numbers alone gives an untrue picture of the strategic situation.

Both Gates and Gen. Nathan F. Twining, Chairman of the Joint Chiefs of Staff, told the House Subcommittee they felt that the new military budget is "adequate."

Asked bluntly if he thought the United States has the strength to hold its own in the decade of the 1960's, Gates replied:

"I would say that I am confident we are in good shape, if you will couple with my judgment the fact that we cannot rest in our easy chairs and that we must continually review the situation."

NSF Fund Request Hiked by $30 Million

Expenditures by the National Science Foundation of $101 million—an increase of $30 million over the current year—are sought in President Eisenhower's FY 1961 budget. The extra money would support "promising" basic research proposals, including space and geophysical work.

The President said grants would be for research in the Antarctic and in "weather modification."

The NSF presently is providing special facilities for radio and optical astronomy observatories, a solar research telescope, university computers and an oceanographic research vessel. It also is supporting some specialized biological laboratories, atmospheric science facilities and the planning for a geophysical institute in Hawaii.

If approved by Congress, the new appropriation would almost double actual expenditures of $55.5 million in FY 1959.

Congress readies hearings . . .

Navy Denies Air Force's PMR Charges

Spokesmen reject AF allegations that Navy has master plan to use range to create its own major space role; Air Force accused of trying to sabotage PMR

The Navy is categorically denying Air Force charges that it is trying to parlay the Pacific Missile Range into a major space role at the Air Force's expense.

At the same time, Navy officials are charging privately that the Air Force is trying to sabotage the future development of PMR in order to make Vandenberg AFB the R&D center for military space programs on the West Coast.

The blunt Navy rebuttal came as:

• Chairman Overton Brooks (D-La.) of the House Space Committee disclosed that his committee is contacting witnesses for hearings on the Air Force-Navy fight.

• The Senate Space Committee continued to prepare for hearings on the interservice struggle within the next few months.

• The Administration appeared to be leaning toward permitting NASA to use available *Thor* pads at Vandenberg AFB for launching *Thor-Deltas* into polar orbits rather than build new pads directly to the south at PMR's Point Arguello. However, no decision has been announced.

• New budget figures showed that PMR is planning to spend about $100 million during FY 1961, of which about $6 million to $7 million will be for construction of new facilities—a long way from the hundreds of millions originally planned.

• In line with Defense Department policy against interservice sniping, the Air Force officially remained aloof, not commenting on either the charges from its own officials or the Navy denials.

The Navy hit directly at the Air Force charges which M/R disclosed last week have been laid before congressional investigators. The Navy said it is "constantly alert in its attempt to recognize any program which might enhance the Navy's ability to carry out its part of national security."

"In this light, there undoubtedly will be programs in the future which sometimes are broadly termed 'space programs,'" it said. "Space is a place and not a program in itself nor a thing."

The Navy denied the Air Force charges point by point. It said:

• The secret Connolly Report is "a study . . . as to what foreseeable programs might possibly enhance the Navy's capability"—not a master plan aimed at giving the Navy a major space role.

• The Navy is not trying to build up PMR at the expense of NASA and the Air Force in order to use it as a springboard for its own long-range space programs. It said it is "implementing the approved programs with regard to the Pacific Missile Range."

• The Navy is not working on a manned maneuverable space system called MMSS.

• There are no plans to develop a clustered *Polaris* for use as a space vehicle. However, the Navy added that "naturally, as it will always do with its weapon systems, every effort will be made to improve the *Polaris* system as time goes by."

• The Navy is not trying to bleed information from advanced Air Force programs to build up naval technical know-how in space. It said "the Navy freely exchanges technical information with other services and government agencies and receives a free exchange of technical information from those services and agencies."

The Navy added pointedly that it "operates within the provisions of authorized programs approved by proper authority."

"Any programs which the Navy has now or might have in the future in the 'space area' will be duly authorized and approved by appropriate authority," it said.

Just this need for appropriate authority points up the running Air Force-Navy struggle. The Administration's long delay in deciding where NASA *Thor-Deltas* will be launched on the West Coast is a prime example.

Originally, the *Thor-Delta* complex was to be built at Arguello. However, the Air Force offered NASA some *Thor* pads at Vandenberg and NASA warmed to the proposal for economy reasons.

The Navy has complained that the launching of *Thor-Deltas* from Vandenberg into polar orbits will expand the number of costly work-stopping overlights that hamper activities at Arguello.

And herein begins to unravel the story the committees plan to hear.

Eleven Nations Ratify IFIPS Laws

Eleven nations have ratified the statutes of the International Federation of Information Processing Societies (IFIPS), which will provide a common meeting ground for computer experts from all over the world.

Countries whose national computer technical societies have ratified the statutes include Canada, Denmark, Finland, France, Germany, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom, and the United States. In addition, Belgium, Israel and Japan are forming national computer societies to qualify for membership.

The new Federation was formed as a direct result of the first International Conference on Information Processing, sponsored by UNESCO and held in Paris last June. A provisional bureau for the Federation was established with Isaac L. Auerbach, president of Auerbach Electronics Corp., named provisional chairman. Auerbach represents the National Joint Computer Committee of the U.S.


Official U.S. Naval Observatory Photo
At 00h 00m 01s GMT
January 1, 1960
Martin logged its
390,660,000th mile
of space flight

Method Makes Long Seamless Cylinders

Seamless metal cylinders with depths totally out of proportion to their diameters are produced by a new process developed by Lodge & Shipley Corp. of Cincinnati.

Termed "Multi-Flo-Reforming," the method extends the recently announced capabilities of a single flo-reforming operation on a Floturned piece. (Flo-Turning essentially consists of the stretching and shaping of metal blanks by "flowing" the metal over a mandrel under the elevated pressure of high-speed rollers. Ordinary flo-turning cannot economically produce long cylindrical pieces of relatively small diameter.)

Multi-Flo-Reforming starts with a blank which is formed by Floturn into a cone. The cone is reformed by a hydraulic press operation into the straight-side cylindrical shape desired. The practical limit of this single-reform operation, particularly when fabricating a shell of great depth and small diameter, is a function of the metallurgical properties of the substance involved.

Lodge & Shipley say that this may be determined through experiment and expressed as the ratio of the major and minor cone diameters of the Floturned cup—the minor cone diameter being equal to that of the finished part.

If, for instance, the characteristic ratio is 2.06:1 (18-8 Type 302 Stainless Steel) and the calculated ratio exceeds this—but not its square, two reforming operations are necessary.

If the square of 2.06 is exceeded—but not the cube, then three reform operations are necessary. And so on to a point as yet undetermined.

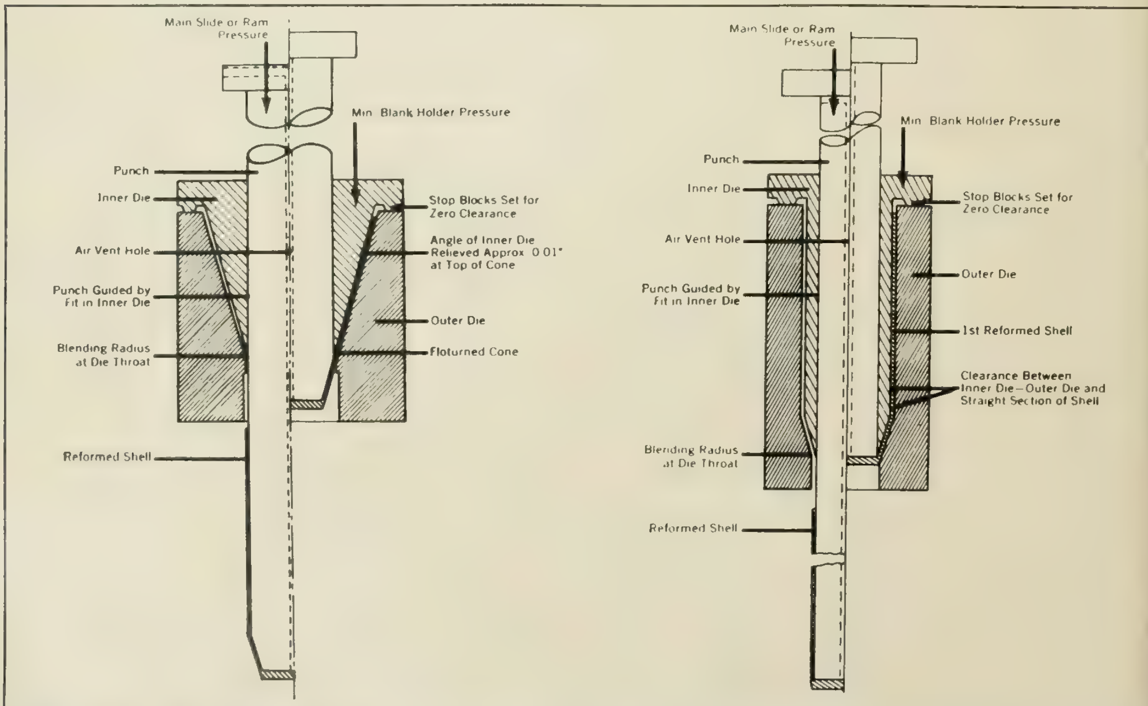
Company spokesmen say there is no theoretical limit to the size of the product possible with the Multi-Flo-Reforming process, but there are difficult practical problems.

A typical example of the process would start with a 7.5-in. diameter blank of 302 stainless. The blank is formed into a 7.75-in. deep cup by Floturn and then elongated to approximately 10.25 in. in the first single-reform step. The second reform step results in a finished cylinder 14 in. long and 2.5 in. in diameter.

This process involves ten operations including washing, annealing, and trimming. A similar product, if deep drawn, would call for about 28 operations including as many as 9 separate drawings.

Not only is it economical; Multi-Flo-Reforming significantly improves the metallurgical properties of the workpiece.

Lodge & Shipley has successfully produced many pieces with two-reform operations and experimental work is being done on three-reform procedures. The single-reform method is currently used by the Navy to fabricate missile components.

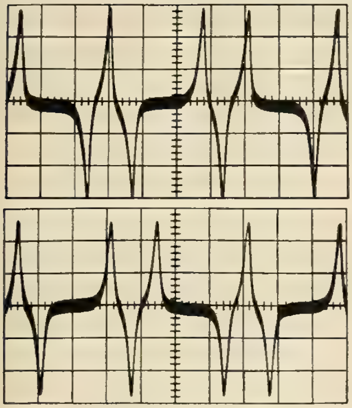


RIGHT HALF of each drawing represents beginning of Reform operation. Left half shows tool set and workpiece at the end of each operation. Note that diameter is same in minor Floturned cone and finished cylinder. Principle of operation is same in both steps except for allowances in second because of "blank" configuration. Standard hydraulic presses are used.

Materials Memo

3M reports on sandwich-type magnetic tape . . . heat reactive tubing . . . sound-deadening pressure-sensitive tape

A LONG-PLAYING "RECORD"



PLAYBACK wave patterns show standard, open oxide tape (top) and sandwich tape (bottom) output characteristics.

Not Bach or Beethoven—it's a different kind of record we're proud to tell you about. It's the news that over 50,000 successive passes through a tape transport (digital or analog) are now possible with the new "SCOTCH" Brand sandwich-type magnetic tape. If you've never bothered to count the number of passes you've been getting, using conventional magnetic tapes, we'll save you the trouble. Sandwich tape offers you 10 times the life of these older constructions. What's more, the economies don't end there. You'll find that costly recording head maintenance and replacement is drastically reduced. And don't sell short the fringe benefits of no oxide rub-off or head build-up. In language that really counts, this means you can avoid the irritating chore of head cleaning after every run. Among those fortunates already using sandwich tape, there have been cases where fewer drop-outs were noted on each successive pass. On running this down, it was found that these have been due to contamination on the heads which was gradually being removed by the tape!

We won't leave you in the dark as to how all this can be possible. The key is the unique sandwich construction. It starts out with the familiar tough polyester base and the high-potency oxide magnetic coating characteristic of 3M's conventional instrumentation tapes. But here's the difference: Bonded over the surface of the oxide coating is an extremely thin protective plastic layer. The oxide then sandwiched between the two films, has no choice but to stay put for prolonged reliable service. Furthermore, the ultra-smooth protective layer lets the tape glide over the head like a wet snake. While this fifty micro-inch separation between oxide and head causes a slight reduction in the high frequency or short wave length response, the medium and long wave length responses are essentially unaffected. Sandwich tape comes highly recommended for digital recording, where you can cram up to 500 pulses per inch. It's tops for most AM, FM and PDM applications, as well.

For those of you who'd like up to 50% more recording time per reel, there's a version with a thinner 1 mil base available. Your local MAGNETIC PRODUCTS representative, or the coupon, will bring more facts.

CONFIDENTIALLY, IT SHRINKS!

Unlike a "Sanforized" shirt, our IRVINGTON DIVISION's new heat reactive plastic tubing is guaranteed to shrink. This unique electrical insulation actually shrinks up to 30% in diameter when exposed for a few minutes to either a radiant heat source or circulating hot air. For example, using a temperature of 300° F, the operation is complete in 4 to 8 minutes. No inflammable or toxic dilating agents are needed. And all the initial flexibility and electrical qualities of this vinyl tubing are retained after contraction. Furthermore, it can provide a tight, smooth, abrasion and chemical resistant insulating cover over even somewhat irregularly shaped objects—like the well-protected pencil on the left.

"SCOTCHTITE" Brand heat reactive tubing is not without its share of credentials. It's approved under military specifications MIL-I-631C, as well as receiving acceptance by Underwriters' Laboratories as a 105° C electrical insulation. The cold brittle point is –20°C, which gives you a fairly healthy operating range. With a 0.016" wall, electric strength is 1000 volts per mil; 3200 psi tensile strength assures you of rugged dependable service. Available sizes range from ½" to 2½" diameters after shrinking.

Applications for this product seem to be as broad as human ingenuity. It's already been used for wire harnesses, condensers, coils, ground straps, bus bars, tool handles, antennae, and dozens of other electrical applications. Why not discuss your needs with your local ELECTRICAL PRODUCTS DIVISION representative?

TRANQUILIZER FOR JITTERY BIRDS

Here's a prescription that will not only calm your nerves, but the shakes in your bird as well. It's a new series of aluminum foil tapes which are specifically designed to control the amplitude of vibration of the solid body to which they're applied. It's well known that uncontrolled vibration amplitude can cause not only annoying sound levels but also structural fatigue. If you're trying to lick either of these vibration problems, these tapes may be your answer. With them you could even make a mandarin's gong vibrate like a slab of lead.

There's nothing greatly mysterious about how they work. Basically, there are two principles involved. First, the added mass on the vibrating panel changes its natural frequency and reduces its vibrating amplitude.

The other principle is much more subtle in that the tape's adhesive dissipates vibrational energies. This is done by converting them to a mechanical shearing action within the visco-elastic adhesive. Presto, the vibration decay rate is improved by an important degree. As you may know, this is a relatively new but established concept.

The #428 tape series is available with 5½, 8, or 12 mil backings. All offer an exceptionally high degree of vibration control per unit weight. They also have good solvent resistance and work well over a range of temperatures.

If vibration within an airframe or instrumentation compartment (to cite just a couple of instances) is a problem with you, let our INDUSTRIAL TAPE DIVISION help you put a damper on it.

FOR MORE INFORMATION...Clip and Mail Today!

Missile Industry Liaison, Dept. VAB-10
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3M COMPANY

MISSILE INDUSTRY LIAISON

Minuteman Lags
But First-Stage Ills Are Called Not Serious

by Frank G. McGuire

Development of the first-stage propulsion system for the Air Force *Minuteman* intercontinental ballistic missile has slipped slightly behind schedule, according to Joseph W. Crosby, president of Thiokol Chemical Corp., sole maker of the first-stage solid-propellant engine.

Crosby said the slippage is not serious. He attributed it to attempts to turn out a missile beyond the present state of the art.

Citing specific problems in the missile's development, Crosby and other company spokesmen said inert parts, design characteristics, and seals in the flexible nozzles were the prime sources of trouble. One problem—that of motor case integrity—has been solved.

Crosby referred only to first-stage problems, not to progress on the second and third stages.

• **Troubles located**—Mechanical problems make up the major part of the developmental headache, Crosby said, adding that the burning duration coupled with the heat of the propellant gases had caused trouble. Since case failure was ruled out as a major source of difficulty now, the problem apparently lies with the nozzles and thrust vectoring systems. Company officials emphasized that there have been no difficulties with the missile's case lining. This would seem to place the trouble in the flexible nozzles—used much like a water hose, to control thrust direction. Sealing in the nozzles was believed to be the main source of failure.

Running down a list of complications encountered in the *Minuteman* program, Crosby noted that until now no one has ever fabricated a case of the necessary size and strengths, and this lack of experience has caused miscalculation. Design of such a large solid propellant motor has also never been attempted before, and rushing the program into areas beyond the present state of knowledge has caused faulty design.

High pressures and temperatures in the long-duration exhaust gases have placed unprecedented stresses on the inert parts of the motor, he added, praising the subcontractors in the program for spending their own funds to solve the difficulties encountered.

All things considered, the company feels the slippage is not serious, and has resulted from a combination of factors, each of which is being attacked vigorously.

• *Zeus* **is behaving**—Contrary to

the problems cited with *Minuteman,* Thiokol is reportedly having no such troubles with *Nike-Zeus.* Although the firm has no production facilities available for the anti-missile missile, the program is doing "quite well" and is on schedule.

Fourth tether test of the *Minuteman* from its underground silo was successful at Edwards AFB recently, but this was not a shot of the full-scale missile. Such missiles are sophisticated mockups for silo checkout.

The most advanced ICBM in the nation's arsenal, the missile is being designed reportedly for use as a multipurpose weapon, using third stage only for a tactical situation, second and third stages for IRBM ranges, and all three stages for extreme distances.

Air Force decision to accept the possible dangers of sole-source procurement on the first two stages, and probably all three stages soon, indicates that the economy axe being wielded in Washington has even hit such vital projects as *Minuteman.*

Rawlings Sees Bright Decade for Electronics

Electronics has cause for greater expectations in the coming decade than any other industry, says Gen. E. W. Rawlings, retired former commander of the Air Force's Air Materiel Command.

Rawlings, a General Mills vice president, told the Ground Communications and Electronics Association meeting in Dayton, that electronics is probably the nearest thing to a technological common denominator for the tremendous achievements anticipated in the '60s.

In a speech before the group, he called the development of molecular electronics a major breakthrough. He said that "this concept . . . which is now entering the practical application stage, has possibilities that would have appeared fantastic only a few years ago. Moreover, it is probable that molecular electronics will greatly improve reliability."

Rawlings traced what he termed "the electronic revolution in defense." He cited radar ranges of 2000 miles compared to the 200 miles of 10 years ago; how heat-seeker homing techniques have increased the effectiveness of air defense and guided missile attack weapons; how scatter systems have improved communications; how digital computers track, calculate the trajectory and impact point of ICBM's; and how communications and reconnaissance satellites to be fired into orbit this year will revolutionize communications and military tactics and techniques.

Titan Tooling Innovations at Martin

Details of unique tank barrel assembly machine developed for Titan fabrication; program also results in new aluminum welding, chemical milling methods

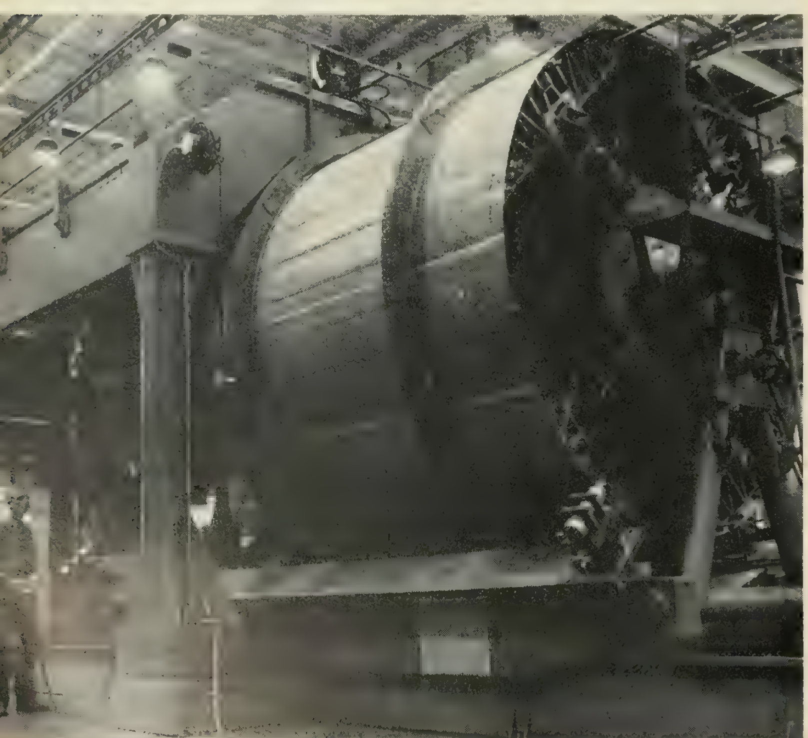
One of the unique steps in *Titan* fabrication at Martin-Denver is a custom-built tank barrel assembly machine.

The device feeds on integrally stiffened, extruded 2014 aluminum alloy skin plates supplied by Alcoa and Harvey Aluminum. Since the plates are received flat and in the T4—or semi-hard—condition, Martin initially runs them through several processes—including rough machining, stretch contouring and chemical milling.

The formed panel is then aged to the T6—or hard—condition.

A group of three of these panels is placed on the assembler, positioned and held by pneumatic, finger-like clamps which grip the "T"-shaped internal stringers. The longitudinal butt joints are secured by actuating the external bridge clamps.

The quarter-barrel subassembly begins as the automatic welding head traverses the welding bridge, closing the seam. The bridge clamps are released, the quarter-barrel assembly moves out from under the bridge and rotates until the next unwelded butt joint is in position. The welding operation is repeated until all four quarter-barrel subassemblies are completed.



BARREL ASSEMBLY machine used by The Martin Company's Denver Division in production of first stages for the *Titan* ICBM. It is the only one of its kind.

The four subassemblies are positioned on the locater paddles and gripped as before. The tank moves under the bridge and the four quarter-barrels are joined. After two electrical cutting heads trim the barrel ends, the entire operation is finished.

The domes are formed from aluminum alloy "orange peel" sections after initial processing, similar to that of the tank panels, has been performed. The segments are positioned in a weld and trim fixture and the joints closed. The dome is rotated around its vertical axis while the edge is routed to size by a built-in head. The circumferential welding is done by tilting the dome 90° and rotating it around its original vertical axis.

The domes join the tank barrels on an automatic rotating fixture. Two dome assemblies are located and clamped in chucks and the barrel assembly is positioned in the roller rings. The segments roll together, forming butt joints which are closed by a welding head, as the entire assembly rotates, in one continuous operation.

The tank is then stringently checked for weld defects by X-ray and other means. Hydrostatic tests and calibration follow and the tank, if passed, is cleaned, rinsed, de-oxidized and protectively coated.

Hot air blasts the tank dry before it is purged with nitrogen to a dew point of +10°F. The tank is sealed and admitted to the next assembly line for integration with the second stage, the transition pieces and the engine fairing.

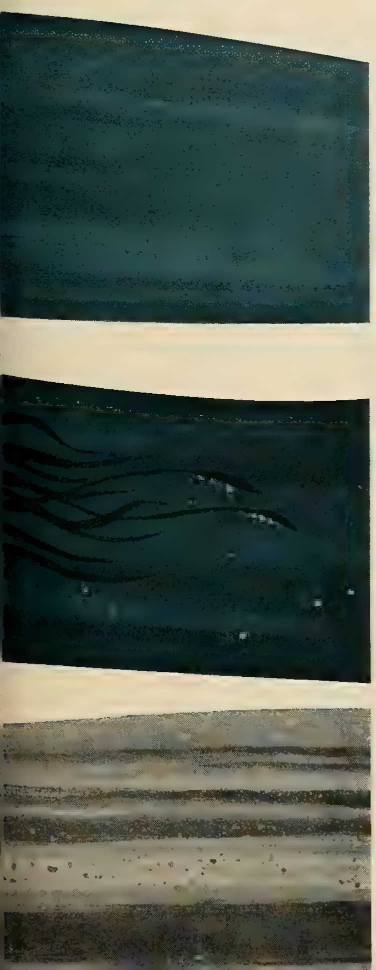
Besides larger machines, the *Titan* has introduced at least two new processes—successful welding of 2014 aluminum alloy and quantity chemical milling.

Spencer Laboratory is named for Raytheon's Senior Vice-president, Percy L. Spencer, a pioneer in tube development.

Lockheed's interest in the virtually unknown 360,000,000 cubic miles of this planet's oceans, stems naturally out of its underwater environmental development work with the Navy's POLARIS Fleet Ballistic Missile.

Proposed studies in the increasingly important field of oceanography include: oceanographic research vessels; measuring instruments; data collection systems; underwater communication and navigation; and basic research regarding natural phenomena and military aspects of the deep sea.

EXPLORING THE WORLD OF WATER



Division Diversification— Oceanography is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology — from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetodynamics; man in space; materials and processes; applied mathematics; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space communications; space medicine; space navigation; and space physics.

Engineers and Scientists — Such programs reach far into the future and deal with unknown and stimulating environments. It is a rewarding future with a company that has an outstanding record of progress and achievement. If you are experienced in any of the above areas, or in related work, we invite your inquiry. Please write: Research and Development Staff, Dept. A-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed /

MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM;
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Circle No. 11 on Subscriber Service Card.

propulsion engineering . . .

By JAY HOLMES

Solid hydrocarbon fuel . . .

is used by Thiokol in its hybrid engine. Security precludes any further identification of the fuel—or any disclosure about the storable liquid oxidizer. The company does say, however, that the propellant combination used in the engine developed by its Reaction Motors Division is hypergolic.

Engineers at Reaction Motors believe the combination of a liquid oxidizer and a solid fuel has a better chance of achieving specific impulse values above 300 sec. than any other non-cryogenic system. The best oxidizers available currently are liquid, they reason, and the best fuels are solid.

Since the specific impulse advantage of bi-propellant liquid combinations is often offset by the low bulk density of the liquids, their idea is to get the hydrocarbon into solid form—obviously by polymerization—and offset this disadvantage without any loss in I_{sp}.

An Air Force contract . . .

supports the Thiokol work. The company's announcement earlier this month (M/R Jan. 11, p. 14) was the third in recent months of progress on hybrid engine development. In October, Aerojet-General reported it had turned up some promising data in studies with company funds. The Naval Ordnance Test Station at China Lake, Calif., said it had achieved a specific impulse between 225 and 265 sec. with a common nonaluminated double-base propellant and an ordinary halogenated oxidizer.

Thiokol spokesmen declared the results of their test programs indicate the high performance and controllability inherent in liquid-solid engines. Shutdown and restart capability also has been demonstrated. The engine is throttleable over the full thrust range.

Problem of handling . . .

cylindrical rocket case sections during manufacturing process is solved by pneumatically operated grabs. Presray Corp., a subsidiary of Pawling Rubber Corp. in Pawling, N.Y., has just received clearance to report wide use of the device, which it calls the Pneuma-Grip.

The handling problem stems of course from the extraordinary sensitivity of high-strength metal to the slightest scratch or the smallest stress concentration. The pressure of ordinary grappling tongs might wrinkle the cylinder wall enough to introduce weak areas. Or a scratch might introduce a notch sensitivity.

Neoprene pneumatic members . . .

channel rings of adjustable size hold the cylinders. Since air maintains the pressure of the members against the metal, the load is distributed equally. Presray, says Avco-Lycoming, General Electric, Allison Division of General Motors, Wright Aeronautical and Kaiser Fleetwings, among others, use the device in handling rocket case sections they make for the *Minuteman* and *Polaris* programs. A spokesman says this is one of the first instances where a small company has been able to standardize a critical materials handling system for many companies involved in a single defense project.

Heat treaters are complaining too . . .

about what they call whimsical tolerance specifications by missile designers. They report that purchasers often state extreme specifications for a part and then recoil in horror when the supplier gives an honest cost estimate. At the last minute, the designer waives the requirements and admits he didn't need them in the first place. Some heat engineers have thrown up their hands in despair and concluded the whole business is a boondoggle.

Unit Monitors Atmospheric Particles

A new atmospheric-particle counting instrument has been designed for application to the continuous monitoring of outdoor air or atmospheres of indoor locations, such as ultra-clean work areas by Royco Instruments Inc. The unit presents, on a strip-chart recorder, a permanent record of aerosols present in an overall range from 0.3 microns to any desired upper limit. This record is differentiated into 15 sub-ranges and recorded in sequence at intervals which can be predetermined in length. Stability problems are eliminated by the fact that the unit is continuously self-calibrated.

Included in the instrument is an alarm system which can be set for a remote indication of particle concentrations in any of the monitored sub-ranges exceeding a predetermined maximum.

Counting rate of the PC-200 is 1000 particles per minute with a 1% coincidence loss at the standard flow rate of 100 cc per minute. Recordings are made on a 6-in. strip chart at a standard movement of 8 in. per hour. Operation is from a 115-v 60-cps supply with a current of 3 amp.

Weighing approximately 150 lb., the unit is 21 x 19 x 32 in. overall. It is mounted on greaseless, dustless casters. Price $6975 f.o.b. Mountain View.

Circle No. 225 on Subscriber Service Card.

Adhesive Aids Bonding Miniaturized Components

The increasing pressure for instrument miniaturization in fields such as computers, missiles and data processing systems has given rise to many critical assembly problems.

Take the case of a recently designed shaft position digital encoder which the ASCOP Division of Electro-Mechanical Research, Inc., is now supplying manufacturers of computers, telemetry and remote control devices, data processing equipment, and so forth.

The device, measuring 2¼" in diameter and approximately 1¼" thick, converts directly into electrical binary code impulses, the shaft position of self-balancing potentiometers, radar antennas, machine tool carriages, navigation and fire control devices, weather forecasting instruments, etc. ASCOP managed to pack the necessary mechanical and electrical components into the compact housing, but an unexpected complication arose—how to attach the plastic insulating sleeve containing the output circuit wires to the cover plate of the housing. This had to be done without employing a connective device which would protrude into the interior of the instrument. This restriction suggested the use of an adhesive rather than a mechanical connector.

In considering the use of an adhesive, ASCOP engineers were faced with the problem of permanently bonding two dissimilar materials; polyvinyl chloride (the sleeve), and anodized aluminium (the cover plate). They were naturally anxious to use as small

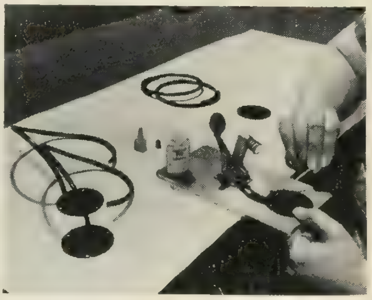
a bonding area as possible and hoped to achieve the bond within a reasonably short period of time.

From the experience ASCOP had had in solving some other unusual bonding problems, its engineering group recommended Eastman 910 Adhesive, recently introduced by Eastman Chemical Products, Inc., subsidiary of Eastman Kodak Co. This high-strength adhesive is characterized by its ability to form rapid bonds with a wide variety of materials. This, plus the fact that it does not require a catalyst, evaporation of solvents, or more than holding pressure, appears to have completely solved ASCOP's problem.

In production, the housing cover is placed on the holding plate of a small toggle jig and the plastic tubing is inserted through the cover so that it protrudes slightly. The protruding portion of the tubing and the area of the cover plate immediately surrounding it is cleaned by wiping with a small quantity of nitromethane solvent after which a small quantity of the adhesive is applied. A Teflon tool attached to a toggle device flares and flattens the end of the tubing against the cover plate. Within 2 to 3 minutes a bond stronger than the plastic is formed.

It should be noted that because of the almost universal nature of the adhesive, it is necessary to coat the Teflon tool with silicon grease to prevent any excess adhesive from bonding the tool to the vinyl tubing.

As mentioned above, ASCOP is using this unusual adhesive in other ap-



plications. In one of these it is necessary to bond aluminium identification plates to modular airborne telemetry instruments. Because these devices must be capable of plug-in assembly on any face with other instruments, the identification plates must be flush with the surface of the housing. In such cases the area to receive the plate is milled out to a depth of about .018 inches, a drop of adhesive applied, and the plate pressed into place. Within minutes the plate cannot be removed without severe distortion.

Circle No. 226 on Subscriber Service Card.

Dead Weight Calibrators Useful on Thrust Stand

Aeroscience Inc. announces a line of dead weight calibrators used in the laboratory to calibrate load cells to a high degree of precision, or in the field to calibrate one or more of the six load components directly on an engine thrust stand.

Two series are supplied. One is a direct dead weight loader applying precision-calibrated dead weights. The second employs a flexurally supported beam balance. The company provides loading units from 5000 lbs. or less, to over 1,500,000 lbs.

These systems employ flexure pivots, which are many times more efficient and reliable than knife-edge pivots. The flexures use a point of rotation which is always fixed. Parts containing critical dimensions are machined from a solid block, making an integral rugged construction which maintains the critical dimensions during hard usage, and pro-

Circle No. 24 on Subscriber Service Card.

vides assured accuracy in measurements,

Units are compact and weight handling is said to be simplified by an efficient amplifying system, permitting use of lighter incremental weights which are easy to handle, require no massive structures, and can be loaded automatically.

Accuracies range from 0.05% of applied load in beam balance calibrators, to 0.01% of applied load in a dead weight type.

Circle No. 227 on Subscriber Service Card.

Integrated Gyro Has Missile Uses

Kearfott Company, Inc. has announced the development of the M-2514-01 Miniature Floated Rate Integrating Gyro, designed primarily to be utilized as a control gyro in fire control or autopilot systems in missiles.

The M2514 features a newly developed high viscosity damping fluid which permits low-temperature storage without detrimental effects to pig-tails.

The wide angle capability of this component permits large angular inputs without consequent loss of reference.

The company says this high performance unit also features an AC drag cup torquer which is capable of high torquing rates, assuring a gyro which responds quickly to command signals.

Circle No. 228 on Subscriber Service Card.

NEW LITERATURE

ETCHING CONTROL. A newly-introduced control material for metals-working industries which employ etching, photo milling, or plating techniques is described in a pamphlet available now from Eastman Kodak Company. Kodak Metal-Etch Resist was developed to assist in accurate and economical control of the removal of superfluous and hard-to-get-at metal from in-process pieces through etching or chemical milling. Kodak Metal-Etch Resist protects the surface of the in-process piece in those areas where the removal of metal is not required or is undesirable. The entire surface of the piece is first coated with Kodak Metal-Etch Resist. The piece is then exposed to high-intensity light, from a carbon-arc or mercury-vapor lamp, through a photographically prepared line negative which "masks" the piece, passing the high-intensity light to areas which require protection and excluding it from areas to be worked. This exposure forms an image of the desired pattern. After treatment with Kodak Metal-Etch Resist Developer, the protected areas will resist the action of the etching solutions. Because it is a non-conducting material which adheres readily to a number of metals, Kodak Metal-Etch Resist is expected to be widely used also in plating to permit the plating of a piece in specific areas, while excluding the plating from other areas.

Circle No. 200 on Subscriber Service Card.

WAVEGUIDE DATA. A new "Standard Waveguide Data Chart," one of the most complete listings of waveguide information available today, has been prepared by the Narda Microwave Corp. Featuring military as well as EIA designation numbers, the chart shows virtually all required electrical as well as mechanical parameters for all waveguides in use today. Some of the parameters covered are: cut-off frequency, theoretical attenuation for both brass and aluminum waveguides, theoretical C.W. power rating, and the waveguide wavelength from the lowest to the high frequency in any given band. Mechanical dimensions are also given for all waveguides, along with their tolerances. This is especially valuable, since these figures can be used as a guide to minimum tolerances throughout the rest of a system under design. Engineers who do not work with microwaves on a regular basis will also be able to use this chart to find radius dimensions, type of flange available—either cover or choke—in both aluminum and brass; as well as dimensional information to help them determine frequency ranges consistent with the mechanical and dimensional requirements of the equipment with which they are working.

Circle No. 201 on Subscriber Service Card.

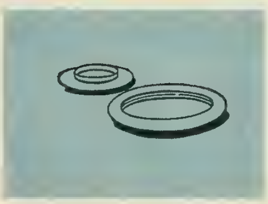
INFRARED GLASS. The fourth in a series of infrared "Progress Reports" has been published by Bausch & Lomb Optical Co., Rochester, N.Y. Report #4 describes three types of glass, specifically developed for refractive systems to be used in the near-infrared part of the spectrum.

Circle No. 202 on Subscriber Service Card.

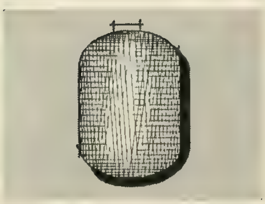
You'll like Garlock's habit of being on time...

At Garlock, delivery of high quality rocket motor components in the shortest time is of prime importance. To meet this objective, research and development, product design, tool design, pilot manufacturing, and production staffs work together as a fully integrated team. By solving problems of design and production jointly, they avoid time-consuming redesigning and retooling.

Flexible, Diversified . . . Garlock will swing into prototype production on short notice and follow this with full scale production as needed . . . will design and manufacture rocket motor components from a variety of basic materials—rubber, metals, phenolics, fluorocarbon plastics.

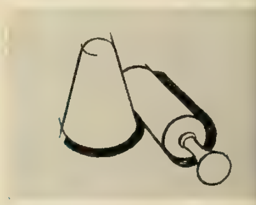


GARLOCK METAL FITTINGS for rocket motor cases such as blast tube and thrust terminator support rings are machined to extreme tolerances. Materials afford minimum weight, maximum strength and rigidity.



FILAMENT WOUND ROCKET MOTOR cases made by exclusive Garlock method result in structure much lighter and stronger than steel.

INSULATION for solid fuel rocket motors made by Garlock is rubber-like compound which encounters gas velocities of Mach 3-5, temperatures to 5500°F, prolonged ambient temperatures of 300°F.



MISSILE PARTS from inert materials including newly developed asbestos-phenolic compound for nozzles . . . nose cones of fluorocarbon plastics.

Garlock engineers will work to your design or help you in developing designs. Call or write Military Products Department, The Garlock Packing Company, Palmyra, New York.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Garlock components are presently used in the development and production of:

- Vanguard
- Super Vanguard
- Polaris
- Terrier
- Minuteman
- Nike Hercules
- Super Tarter

Hébert Legislation May Pass Congress

Opposition to establish uniform curbs on 'influence peddling' expected to be slight, but attempts to strengthen House bill may result in battle

Despite its failure to establish any wrongdoing, the Hébert Subcommittee's recommended legislation to establish uniform curbs on "influence peddling" in connection with defense contracts is expected to receive congressional approval.

Opposition will be negligible. But there is a possibility that a controversy may develop over attempts to make the measure even more stringent.

As sent to the House Jan. 19, the bill specifically bars all former military and civilian personnel from selling to the Pentagon for two years after leaving DOD service. However, some lawmakers are known to favor upping the "keep out" time to a period of three years or more.

It is also possible that a new definition of "selling" included in the House Armed Services Investigations Subcommittee report accompanying the legislation also may be written into the bill. This is set forth as:

"Selling to the Government includes all activities which bring a contractor and his representatives into contact with officials of the Department of Defense for the purpose of obtaining contracts from that Department for the procurement of tangibles or intangibles in existence at the time or to be produced in the future; and the participants in such transactions are a part of that process."

• **"No escape"**—Subcommittee Chairman F. Edward Hébert (D-La.) said this was intended to be a "no escape" definition. "No excuses on account of the *kind* of a thing sold, whether *tangible* or *intangible,* in *existence* or to be *produced.*" He said, "beer and turbines, planes and weapon systems, get the same treatment. Pounds and proposals are weighed in the same scale."

Heretofore, selling has been defined in military transactions as almost exclusively dealing with the exchange of money. The new definition, if not incorporated in the bill, will become part of the legislative history. Maximum penalties for those found in violation would be a $10,000 fine, a year in jail, or both.

The subcommittee also recommended repeal of the Navy's present life-time prohibition against selling. Citing several conflicting regulations, the investigators said a clearly-delineated law with a two-year "cooling off" period for all the services was the best answer.

In addition, the subcommittee asked that the law be changed to permit the secretary of defense to waive present dual compensation regulations on a temporary basis so that DOD can rehire "indispensible" men. At hearings last year, there were complaints that retired military men had no choice but to go to industry. For they would forfeit retirement pay by taking a job with the government.

• **Code asked**—The subcommittee called for establishment of a "Code of Ethical Conduct"—like that of the American Bar Association—which would continue after the cooling off period. The code, however, would prohibit them from ever directly engaging in matters which that had specialized in while in the service.

The code—to be generated by DOD—would require:

• A retired commissioned officer to notify DOD when taking a job with a defense firm.

• DOD to organize a central public file of the information.

• Defense contractors to list for DOD on the effective date of a contract the names of all retired officers on the payroll. Primes would be required to furnish information on behalf of their subs. Failure to comply "shall cause the suspension of all payments, whether retired pay or contract payments, as the case may be, until such information is furnished."

Revealed in the report were the names—and pay—of 240 retired flag and general officers now working for defense contractors. Of the top 100 DOD contractors, the subcommittee said a survey showed 72 had retired military personnel of all ranks on their payrolls—the highest at $100,000 per year—and the remaining 28 had none.

Total number of retired captains and lieutenant commanders and above surveyed was 1401. The report noted there were 33,326 regular Army, Navy, Marine Corps and Air Force officers on the retired lists as of last June 30—3353 of flag or general rank. "Thus, we are not dealing with substantial numbers of persons considering total defense contractor employment," the report said.

• **Newspaper ads deplored**—No changes were asked in the laws governing taxes, advertising, entertainment or trade associations—four subjects also explored by the investigators during the lengthy hearings. However, the report deplored the newspaper advertising controversy between Boeing's *Bomarc* and Western Electric's *Nike-Hercules* interceptor missile programs as "detrimental" to the defense effort. Said the subcommittee: "It provokes controversy and promotes dissension, and introduces biased, narrow, and prejudicial considerations into purely military decisions."

While not mentioning The Martin Co. by name, investigators said they would let the previously released documentation of the firm's entertainment of high-ranking military officers in the Bahamas stand as their "commentary." But, then they added, "public confidence is undermined, especially when both propriety and discretion appear to be wanting in the personal codes of many persons in high places."

Such organizations as the Association of the U.S. Army, the Navy League, the Air Force Association and Aerospace Industries Association, the report said, accumulate many millions of dollars. "Its use, either good or bad, depends upon the degree of discretion of officials and directors." Investiga-

tors said they felt the recent Internal Revenue Service ruling disallowing tax deductions on dues to organizations for lobbying activities was an effective way to handle the situation.

Hébert himself seemed somewhat skeptical as to the effectiveness of his proposed law, even if adopted.

No.	Defense position	Name of company	Total number of employees	Number of retired military officers employed	Number of retired flag and general officers employed
1	1	Boeing	89,981	61	5
2	2	General Dynamics Corp.	91,700	186	27
3	3	General Electric	282,029	26	7
4	4	Lockheed	45,530	171	27
5	5	United Aircraft	61,688	24	5
6	6	A. T. & T.	(1)	6	0
7	7	North American	54,660	92	8
8	8	Douglas	76,400	40	5
9	9	The Martin Co.	27,269	63	9
10	10	Hughes Aircraft	(1)	22	5
11	11	Sperry Rand	101,016	30	3
12	12	Chance Vought Aircraft	16,596	16	3
13	13	McDonnell Aircraft	27,107	5	2
14	14	IBM	83,782	9	1
15	15	RCA	78,000	35	15
16	16	Northrop Aircraft	25,600	26	4
17	17	General Motors	(1)	6	2
18	19	Republic Aviation	10,675	14	4
19	20	Chrysler Corp.	136,187	12	3
20	21	Grumman	13,000	14	3
21	22	Raytheon	28,347	19	2
22	23	Curtiss-Wright	26,311	7	1
23	24	Bendix Aviation	50,266	29	3
24	26	General Tire & Rubber	28,000	66	11
25	27	Ford Motor Co.	191,759	7	1
26	29	Fairchild Engine & Airplane	12,711	12	5
27	30	I. T. & T.	128,000	44	14
28	31	Avco Manufacturing Co.	24,569	8	6
29	32	Bell Aircraft	15,000	3	1
30	33	The Texas Co.	53,340	5	0
31	34	Continental Motors Corp.	5,600	5	0
32	35	Burroughs Corp.	33,000	14	3
33	36	American Bosch Arma	7,704	0	0
34	37	Socony Mobil Oil	(1)	1	1
35	38	Philco Corp.	19,983	29	3
36	39	Thompson Ramo Wooldridge	19,352	12	5
37	40	Cities Service	(1)	3	1
38	41	Collins Radio Corp.	10,092	11	1
39	42	Marquardt Aircraft	3,700	9	0
40	43	Hayes Aircraft Corp.	1,200	11	1
41	44	Olin Mathieson	39,000	4	1
42	45	Food Machinery & Chemical	15,103	10	2
43	46	Goodyear Tire & Rubber	101,386	8	1
44	47	Thiokol Chemical Co.	2,911	12	1
45	48	Newport News Shipbuilding	12,452	14	2
46	49	General Precision Equipment	1,500	12	6
47	51	Garrett Corp.	11,020	4	2
48	52	Tidewater Oil Co.	9,763	4	0
49	53	Bethlehem Steel Corp.	(1)	12	3
50	54	Lear, Inc.	3,868	2	1
51	55	Sylvania Electric Products Co.	27,300	19	1
52	56	Firestone Tire & Rubber	88,323	4	0
53	57	The Rand Corp.	(1)	14	6
54	58	Marine Transport Lines	(1)	1	1
55	59	Bath Iron Works	1,531	2	1
56	61	States Marine	(1)	1	0
57	62	Kaman Aircraft	1,270	1	1
58	63	Westinghouse Air Brake	17,275	1	0
59	64	Todd Shipyards	8,468	11	0
60	66	Motorola, Inc.	12,000	12	1
61	68	Temco Aircraft	7,839	11	3
62	70	White Motor Co.	8,800	1	0
63	72	Shell Oil Co.	40,465	4	1
64	73	Fairbanks Whitney	(1)	4	3
65	75	Hercules Powder	11,179	1	0
66	76	Eastman Kodak	50,300	5	0
67	77	Richfield Oil	6,177	3	0
68	78	Cessna Aircraft	5,556	1	0
69	80	Beech Aircraft	8,128	2	0
70	83	Ryan Aeronautical Co.	7,134	54	7
71	84	Union Carbide Corp.	77,000	8	1
72	18	Westinghouse Electric	128,572	31	9
		Total	....	1,426	251

(1) No figure available.


POLARIS
U.S. NAVY
The Navy's deterrent weapon system will be
READY THIS YEAR!
The day of the mobile missile base is close at hand. Four of the Navy's nuclear-powered, ballistic-missile subs have already been launched. The missile they'll carry—the Lockheed-built Polaris—is undergoing its final tests. This year, America will have a deterrent weapon that is safe from surprise.
LOCKHEED
MISSILES & SPACE DIVISION

AAS Hears New Propulsion Concept

by Jay Holmes

A Martin Co. scientist proposes development of a space propulsion system based on a series of 0.01 kiloton nuclear explosions.

Dandridge M. Cole of Martin's Denver Division told the American Astronautical Society convention last week in New York that an average thrust of 800,000 lbs. can be generated with the explosion of one pulse per second with a 0.01 kiloton bomb encapsulated with liquid. He assumed 40% conversion of bomb energy to rocket exhaust energy.

The Martin Co. scientist said his plan has no relationship to Project *Orion*, a highly classified study of the feasibility of propulsion by contained nuclear explosions being conducted by General Dynamics Corp. for the Defense Department.

Cole, who offered three differing types of systems, said all would be cheaper and provide larger payload fractions than chemical or nuclear heat-exchange propulsion for very large vehicles.

One model, which Cole said could be based on state-of-the-art design, would accelerate a 350,000 lb. payload through a velocity change of 26,000 feet per second. It would use 2400 capsules and slightly more than 2,000,000 lbs. of water as propellant. Although this would be sufficient to lift from the earth's surface, Cole said departure from orbit might be preferred to avoid atmospheric contamination. If so, he said, a *Nova*-like booster rocket could be used.

Looking farther into the future, Cole also outlined parameters for larger nuclear pulse rockets and a nuclear pulse jet, which would use air as an expellent during its passage through the atmosphere.

• **"Clean" bombs possible**—On the assumption that the latter types would require 10 years or more for development, Cole said it is possible that "clean" bombs could be developed by that time, avoiding the contamination problem. He made no estimate of the time required for developing a nuclear pulse rocket of "state of the art" design.

The energy capsules are the largest item in the cost of such as system, Cole declared. Nuclear bombs are now reported to cost $250,000 apiece. He said it may be possible to reduce the cost to between $10,000 and $100,000 apiece, thus leading to total propellant costs between $24 and $240 million and payload costs of between $70 and $700 per lb. Lower costs will result from development of larger vehicles, he added.

• **Defends Mercury policies**—At another session, Brig. Gen. Don R. Flickinger, USAF, vigorously defended policies for selection and training of the first group of astronauts.

At a man-in-space symposium, a floor speaker noted that all seven astronauts are married and questioned whether this was advisable, since a bachelor might be willing to take greater risks.

Flickinger, who has charge of the man-in-space program for Air Research and Development Command, declared that neither the marital status nor religion of the candidates was known by the selection board. Lt. Col. Stanley White of NASA's Langley Research Center remarked that only one or two of the original 500 test pilots considered were single.

Flickinger also disputed the proposal by Dr. T. C. Helvey of Radiation Inc. that tranquilizers and other drugs be administered to astronauts taking off on long missions to combat the development of hallucinations.

Helvey said that drugs might be useful to combat fatigue, to create desirable hallucinations and to stimulate desirable actions. The other panelists, A. M. Mayo of Douglas Aircraft Co. and Lt. Col. Burt Rowan of Edwards Air Force Base, joined in opposition to the idea. Flickinger said ARDC studies showed the best way to combat hallucinations is to keep the man busy.

The Radiation Inc. scientist also suggested a relaxation of what he called the "very conservative" maximums for radiation dosage of astronauts, based on the Atomic Energy Commission standards for industrial workers.

Helvey argued for the philosophy that a man exploring space can take as much risk from radiation and other dangers as a soldier going into battle.

• **Other papers**—In other papers given at the Society's sixth annual meeting:

• Lithium vaporization was proposed as a system for cooling ballistic nose cones. Henry K. Hebeler of Boeing Airplane Co. said a system based on liquid lithium would be much lighter than a beryllium heat sink or an acrylic ablator, and competitive with a quartz ablator.

• Cost of transporting a pound of material to the surface of the moon can be reduced with chemical propellants to about five times that of carrying it to a low-altitude earth orbit, Robert Cornog of Thompson-Ramo-Wooldridge estimated. The cost can be cut in half with a high-thrust nuclear rocket having a specific impulse of 930 sec.

• A nuclear rocket engine, even with 17,500 lbs. of personnel shielding, requires vehicles of smaller gross weight than a chemical system based on liquid hydrogen and liquid oxygen, three Aerojet-General scientists reported. A. H. Flagg, H. S. McQueen and C. H. Trent based their calculations on a minimum specific impulse—700 sec—for the nuclear rocket.

• Beryllium was suggested as an ablating-type heat sink for very short-time applications by J. Frisch of the University of California.

• Midcourse correction to reduce target miss was analyzed by Jack Lorell of NASA's Jet Propulsion Laboratory.

• Methods of computing radiation dosage in space flight were outlined by Angus F. Bond, Michael G. Del Duca and Andrew D. Babinsky of the Tapco group, Thompson-Ramo-Wooldridge Inc.

• A straight-line flight plan to reach Mars was suggested by Dr. T. C. Tsu of Westinghouse. The one-way trip would require just over three months, compared with nine months for a curved trajectory. Dr. Tsu said straight line flight could be accomplished by continuous propulsion, either by a solar sail or an electric propulsion system.

RCA Opens Communications Laboratory in Arizona

A new surface Communications Systems Laboratory was dedicated recently by the Radio Corp. of America at a site 20 miles southeast of Tucson, Ariz.

RCA said the 13,000-sq.-ft. facility will be used for work on advanced electronic systems such as the global communications program for the Air Force and the *Minuteman* solid-fueled missile. It will also provide quarters for development work on a complete area communications system for the Army.

An RCA official said the Tucson Laboratory would supplement other facilities the corporation has established in the far West, including the major electronics center under construction at Van Nuys, Calif.

E. B. on the FBM

Subcontractors Get 25% of Boats' Cost

WASHINGTON—About 25% of the $50 million the Electric Boat Division receives for a nuclear submarine is spent with subcontractors, a company official estimates.

William G. Atkinson, contract control manager for the George Washington, told this to a recent luncheon meeting of the National Rocket Club. Electric Boat, a division of the General Dynamics Corp., receives about half of the total $100 million cost of a nuclear sub.

Atkinson said most of Electric Boat's expense is labor in putting the vessel together. The subcontracting is mainly for pumps, valves, metal and other raw materials.

Asked about the date of the first test launching of a *Polaris* from a sub, Atkinson said merely that it would be this year. The Navy schedule calls for *Polaris* missiles to be operational this year aboard the USS George Washington, which was commissioned last month.

Atkinson declared that the navigation problem involved in accurate *Polaris* firing has been solved. He said the problem is much greater because a sub is moving constantly and it is not always possible to take a celestial fix. Nevertheless, he said, navigational aids are available and will do the job.

Electric Boat and Reynolds Aluminum are jointly studying the possibility of using aluminum hull plates, he reported, but thus far the decision has been to stay with steel. Aluminum is used in nuclear subs for non-strength members, however, he added.

In answer to other questions, Atkinson added:

- **Superior sailors** are assigned to the *Polaris* submarines. It isn't true that the complex weapon system is getting beyond the sailor's capability. Each sub has two crews. The crew ashore receives constant training.
- **Submersible submarine tenders** are feasible—depending on just what mission they should perform.
- **Building facilities** at Groton, Conn., are not taxed to the limit. He knows of no plan by E. B. to acquire another shipbuilding facility, on the West Coast or elsewhere.
- **Closed ecological** environment experiments are in progress at E. B. The problem in a sub is similar to that in a space ship. Men must live in a closed capsule for long periods of time with a hostile environment—whether water or airless space—outside the capsule.

So. Cal. Expects to Keep 15%

Southern California expects to maintain its present 15½% of the nation's total defense dollar during calendar 1960 and fiscal 1961, according to opinions expressed by the area's industry leaders at a business outlook conference in Los Angeles.

On a statewide basis, California is expected also to hold its current 22% slice of defense spending. Year-end statistics show that 1 out of every 15 persons employed in the state is in defense work of some type—280,000 in Southern California alone—against a state total of 391,000. Employment, however, will shift within defense industries during the coming year to reflect military procurement changes.

Key points stressed at the conference were:

- Continued emphasis on missiles and space systems with at least a 10% increase in total sales and a moderate increase in total missile industry employment.
- Increased competition for contracts at both prime and sub level with longer gaps between contracts. Economic effect on winners and losers will be greater than ever.
- More movement of personnel between companies.
- An increase in electronic industry employment of about 20%, but overall electronics expansion for 1960 will be at a rate below that of prior years.
- Missile and space vehicle propulsion industry will remain relatively stable at its present 10,000 employee level in Southern California. Propulsion business is expected to increase after 1960.
- Missile support, test and checkout equipment will gain as a factor in Southern California defense industry with a resulting increase in this type of business.
- Research and development business will definitely increase in an expanding search for new product development.

Speakers pointed out the other side of the picture, too, but with objectivity and little pessimism.

- The effects summit conferences may have on military spending. Any changes from this factor would probably not be felt for another year or two, however.
- Reduction in aircraft employment in the immediate future with new aircraft developments coming after 1960 at a reduced rate of production.
- Fewer items to be produced because of the increased capabilities of each item.
- All production runs will be limited in both time and number.
- Many local missile programs are reaching full production. Additional production will depend upon attrition through test firings and development of alternate uses.

Redesigned, Lighter *Thor* Passes First Flight Test

CAPE CANAVERAL, FLA.—A streamlined *Thor* IRBM, redesigned from head to toe to obtain much greater range and payload for use in space probes, has proved successful in its first test.

A cone-shaped aluminum fairing, which adds 8 feet to the regular 65-foot height, reduced some of the drag created by the Douglas *Thor's* normal blunt-nose shape in its upward flight through the atmosphere. The new fairing was built by the General Electric Co. Missile and Space Vehicle Department.

In the engine, weight was saved by wrapping the combustion chamber with fiber glass, a process first introduced in the *Atlas* ICBM (M/R Dec. 28, pp. 18-19). The start sequence and pumping system were modified to produce greater thrust.

North American's Rocketdyne Division, manufacturer of the engine, also believes that reliability will increase because the number of components was decreased.

In the first test Jan. 14, a data capsule was picked up less than two hours after launch 1700 miles down the Atlantic Missile Range to the normal target area off Antigua. The shot was not a part of the *Thor* military test program, which had already been ended by the Air Force.

The engine redesigns took advantage not only of the *Atlas* improvements but of modifications of the Rocketdyne H-1 engine required for clustering it into the *Saturn* booster. The engine originally had 135,000 lbs. thrust. Current military models used in the *Jupiter* and *Thor* IRBM's had increased the thrust to 150,000 lbs. For the *Saturn*, the H-1 has been increased to 188,000 lbs., so that eight of them will total 1½ million lbs.

The new *Thor* is taking advantage of the H-1 improvement for the *Saturn*. However, it has not yet reached the full 188,000 lbs. thrust. The actual thrust achieved is classified. Speculation puts it in the neighborhood of 170,000 lbs.

The new GE fairing, a long cone, shrouded the *Thor's* blunt, heat-sink type re-entry vehicle and reduced aeronautical drag on the upward flight. It was separated from the re-entry vehicle by a small explosive device immediately after shutoff of the rocket engine. Then the vehicle continued its space flight in the normal manner.

The major change in the engine is the increased capacity of the turbopump assembly—achieved simply by running the two pumps faster. Simplification of the start sequence was also achieved, along with a reduction of the number of components.

In the combustion chamber, fiber glass filament winding, impregnated with an epoxy resin, replaces the steel bands formerly used as restraining material around the outside. The substitution saved more than 50 lbs. of weight. The process is similar to the fabrication of laminated fiber glass solid-fueled rocket cases.

Thor engines are produced at the Rocketdyne plant in Neosho, Mo. R&D was done at the division's main plant and propulsion laboratory at Canoga Park, Calif.

Atomic Fuel Gauge Is Developed for the Navy

A fuel gauge which uses gamma radiation to measure the amount of propellant in missile and aircraft tanks has been developed for the Navy by Atomics International Division of North American Aviation.

Radiation sources and detectors mounted on the sides of each fuel tank, and gamma rays pass through the fuel supply, decreasing in intensity. The amount of fuel is determined by the intensity of the rays reaching the detectors. A ratemeter converts pulses picked up by the detectors into d-c voltages which record the quantity of fuel in pounds on an indicator or provide a signal to a telemetering output.

The gauge is said to be capable of measuring amounts of fuel with greater accuracy and reliability than conventional devices. It has been environmentally tested at altitudes to 38,000 feet, and has performed accurately at all flight attitudes.

All types of solid and liquid propellants can be measured by the lightweight transistorized gauge, and its performance is not affected by impurities in the fuel. Easily installed, it automatically compensates for differences in hydrocarbon or petroleum-based fuels which affect the accuracy of conventional units.

• **New York**—Brig. Gen. Don R. Flickinger, head of the Air Force life science space program, predicts Russia will orbit two men in a space capsule this year—possibly when President Eisenhower is visiting Russia in June. He believes Russia has solved all the technical problems of getting the men up and their re-entry.

• **Andrews AFB, Md.**—Lt. Gen. Bernard A. Schriever, ARDC commander, said both the U.S. and Russia "have an equal chance of putting a man in space first." But he declined to estimate just when this country would attempt a manned shot. Expressing doubt over reports the Soviets had already put "people" in space, Schriever said, "I just don't go along with the idea that we are way behind in space."

• **Washington**—General Dynamics Corp. with $1.61 billion total contract awards, or 7.2% of the total defense dollars, led the list of the top 100 DOD contractors in FY 1959. G-D edged out Boeing Airplane Co., which dropped from first into second place with $1.167 billion net contracts. North American—with contracts totalling $1.018 billion—was third and General Electric was fourth with $914 million in new contracts. Others in the top 10: Lockheed—$898.5 million; Douglas—$676.4 million; United Aircraft—$538 million; Martin—$524 million; Hughes—$494 million; American Telephone & Telegraph—$476.5 million.

• **Marshall, Tex.**—Thiokol reported it was able to resume partial production Jan. 18 at a solid-fuel mixing building just 10 days after it was damaged by an explosion. There were no injuries. The company's Longhorn Division said the accident did not impair deliveries of *Nike-Hercules* engines to the Army.

• **Washington**—Mergers & Expansions: Boeing Airplane Co. has entered into an agreement to buy Vertol Aircraft Corp. Subject to stockholder approval Feb. 15 . . . Bell & Howell shareholders have okayed the acquisition of Consolidated Electrodynamics Corp. . . . Electro-Pulse Inc., Culver City, Calif., is merging into Servo Corp. of America as its West Coast subsidiary . . . General Electric has set up a new defense systems engineering company—Apparaten-industrie Defense Electronics N.V.—at the Hague, Netherlands . . . At Los Angeles, Aeroquip Corp. has opened an 11,000-sq.-ft. addition to its Marman Division.

Autonetics Sets Up MM Group

A *Minuteman* System Management Division has been set up at Autonetics division of North American Aviation in Downey, Calif., to handle work on the company's $115-million *Minuteman* guidance contract.

Jesse Y. Bowman, former *Minuteman* program manager, has been named system manager. R. E. Moore will be his assistant manager.

The contract is an Air Force research and development contract for fabrication and test of inertial guidance and flight control systems. It also covers ground support equipment for the solid fuel intercontinental ballistic missile which is to be a successor to the Convair *Atlas* and Martin *Titan*.

The new division was formed to provide management skills consistent with current and future program requirements, according to the North American announcement.

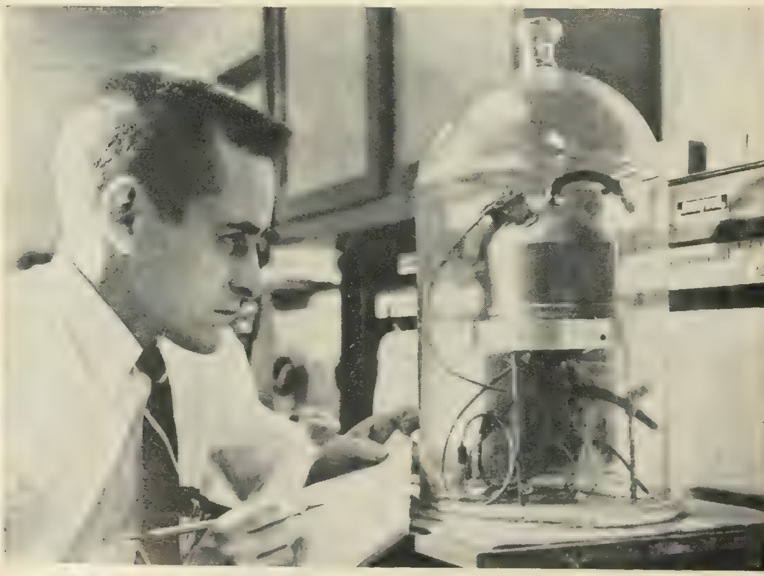
The new group will have responsibility for over-all management of NAA's *Minuteman* program.

North American says formation of the new division is an additional step in reorganization of Autonetics which started several months ago with the establishment of four product divisions: Armament and Flight Controls, Computers and Data Systems, Inertial Navigation, and Industrial Products.

Four technical and administrative divisions also were set up: Research and Engineering, Market, Financial and Central Operations.

Appointed to posts in the new division were C. H. Sword, contracts and controls manager; R. M. Osborn engineering manager; E. R. Buxton assistant engineering manager; C. P Ballard, system test manager; W. A Chapin, quality control manager; E. E Ashworth, purchasing agent; E. B Lindaman, master programming, and M. C. Biging, administrative assistant.

Snap Generator Still Producing



SNAP-3 midget electrical generator fueled with radioisotopes has operated successfully in a vacuum and at temperatures down to 100° below zero. Martin's Nuclear Division, which designed and built the units for the AEC, reports that the original generator was still producing electricity after a full year of continuous operation.

Another example of FIBERITE at work...

Supplying COMPRESSION MOLDED high temperature insulation materials for vital missile parts.

FIBERITE
Compression molded nose cone

Fiberite No. 4030-190, Fiberglas reinforced phenolic compound; Fiberite No. 2619 Fiberglas tape reinforced phenolic compound; selected for physical characteristics, minimum erosion, dimensional stability, and shock resistance.

FIBERITE
Compression molded convergent cone

Fiberite No. 6500 asbestos reinforced phenolic; Fiberite No. 4030-190, Fiberglas reinforced phenolic; Fiberite No. 2630, graphite cloth reinforced phenolic; these compounds are selected for both thermal insulation and erosion resistance.

FIBERITE
Compression molded blast tubes

Fiberite No. 1370, graphite and ceramic fiber reinforced phenolic; Fiberite No. 2630, graphite cloth reinforced phenolic; these compounds are selected for erosion and ablation characteristics at temperatures exceeding 5000° F.

FIBERITE
Compression molded exit cone

Fiberite No. 4030-2194, Fiberglas reinforced phenolic; Fiberite No. 1344-67, quartz fiber reinforced phenolic; Fiberite No. 2625, silica fabric reinforced phenolic compound; selected for their erosion resistance at the high temperature and velocity of rocket exhaust gases.

There is a FIBERITE formulation for your missile application

Sound insulation technology calls for increasing the use of compression molded high temperature materials. Fiberite has ready developed formulations to meet engineering specifications for nose cones, convergent cones, blast tubes and exit cones. These specifications call for erosion resistance, ablation characteristics, thermal insulation, dimensional stability, and shock resistance at temperatures exceeding 5000° F. Fiberite compounds provide predictable results; also such advantages as minimum machining and reduced weight to strength ratios.

Missile project engineers will find our research helpful in solving problems requiring materials for special performance. Write us for our latest catalog of missile molding compounds.

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people

Peter Schenk, former president of the Air Force Association and assistant to the president of Raytheon Co., goes to the Mitre Corp. on Feb. 1 as executive vice president.

Alfred H. Canada, manager of advanced engineering physics for General Electric's advanced electronics center: selected to fill a one-year appointment on the analysis staff of the Institute for Defense Analyses in Washington, D.C.

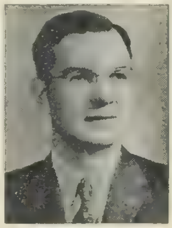

CANADA

Canada's appointment to IDA is part of a program designed to bring together top scientists and engineers from industry and education in a brainpower pool to supply technical support to the nation's military research and development effort.

He holds eight patents and was awarded a medal of commendation for infrared development.

Dr. Fred P. Baughman, formerly a special services engineer with E. I. du Pont de Nemours & Co., joins Taylor Fibre Co., as a group leader in the technical department heading up the physical chemistry-fundamental studies group section.

Dr. Ralph A. Schaefer: named director of an enlarged research and development department of engineering at The Bunting Brass and Bronze Co.


SCHAEFER

Dr. Schaefer, who joined the firm a year ago, was formerly technical advisor to the president of Clevite Corp.'s Graphite Bronze Division. He holds many patents and has a number of developments to his credit in the laminated sleeve-bearing and sintered-metal fields.

H. S. W. Massey, leader of Britain's space research team and the Quain Professor of physics at University College, London, was one of the few scientists featured in Queen Elizabeth's New Year Honours list. He is to become a knight. He will visit America this month with detailed proposals for a joint Anglo-American satellite launching program. He and his team will discuss with NASA officials such questions as the payload space which will be available to them in the *Scout* vehicle, so that a decision can be taken on the type of instruments which Britain will construct.

Also on the Honours list were **Sir George Horatio Nelson,** Chairman of English Electric Co. Ltd., who becomes a Baron; **Rear-Admiral Sir Matthew Sausse Slatter,** Chairman and Managing Director, Short Brothers and Harland, Ltd., a Knight of the Order of the British Empire; and **H. Lloyd,** projects officer on *Black Knight* for Saunders-Roe, Ltd., a member of the Order of the British Empire.

Dr. Lloyd G. Lewis: named manager of Electronic Associates, Inc.'s newly formed process control group. He was previously with Standard Oil of Indiana as head of the analog computer section and was responsible for design and development of several servo systems.

Earl Q. Bowers and **Richard J. Dempsey,** design development engineers, join The National Cash Register Co.'s Electronics Division.

Bowers, formerly a Hughes Aircraft Co. engineer will work on design and checkout of a digital computer. Dempsey, previously with North American Aviation, Inc. and Servomechanisms, Inc., joins a circuit analysis group.

contracts

NASA

,000—**Northrop Aircraft, Inc.,** Van Nuys, Calif., for airborne pressure devices for *X-15*.

MISCELLANEOUS

)0,000—**Cubic Corp.,** San Diego, for racking and radar equipment to be used on Project *Mercury*. Subcontract rom **Bendix Aviation Corp.**

,000—**Laboratory for Electronics' Computer Products Division,** Boston, for roduction of Bernoulli-Disk Memory ystem. Subcontract from **Lockheed's** lissile and Space Div.

NAVY

,000—**Yardney Electric Corp.,** New York ity, for manufacture of silvercel silverinc batteries for Mark 32 torpedoes.

,612—**IT&T, Federal Division,** Clifton, I.J., for modifications to simulator, adar signal artillery and guided missile perator trainer device 15D2.

,400—**Sperry Piedmont Co., Div. of perry Rand Corp.,** Charlottesville, Va., or tender tools and test equipment for IK 19, Mod 3 gyro compass.

AIR FORCE

)0,000—**Westinghouse Electric Corp.,** or mobile type search radar sets and pares.

)0,000—**GPL division of General Preision, Inc.,** Pleasantville, N.Y., for airorne navigation systems.

)0,000—**IT&T Corp.,** Ft. Wayne, Ind., or defensive electronic counter meas-re checkout system for the B-58 omber.

$1,000,000—**American Machine & Foundry Co.,** Greenwich, Conn., and **American Car and Foundry Division of ACF Industries, Inc.,** for design and development of railroad rolling stock for the *Minuteman* ICBM program plus preliminary design of launch car superstructure and provisions for erecting and leveling the missiles. Subcontract from **Boeing Airplane Co.**

ARMY

$35,271,000—**Raytheon Mfg. Co.,** Waltham, Mass., for work on *Hawk* system. (Three contracts.)

$10,500,000—**The Martin Co.,** Orlando, Fla., for the *Pershing* system.

$7,500,000—**Radioplane Div., Northrop Corp.,** Van Nuys, Calif., for production of 400 RP-76 rocket powered target missiles.

$6,303,393—**Continental Motors Corp.,** Detroit, for engines and spare parts.

$5,816,800—**Western Electric Co.,** New York City, for research and development on *Nike-Hercules*.

$2,962,262—**Bechtel Corp.,** Vernon, Calif., for construction of *Atlas* silo launch test facility at Vandenberg AFB.

$1,735,071—**Union Carbide Consumer Products Co.,** New York City, for dry batteries.

$1,136,771—**Brown Engineering Co., Inc.,** Huntsville, Ala., for engineering and machine shop services.

$1,000,000—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for *Nike-Hercules* system components.

$951,001—**The Martin Co.,** Orlando, for engineering services for *Lacrosse* system.

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U. K. Starts Satellite Studies

by Anthony Vandyk

NICE, FRANCE—The United Kingdom government has started design studies for adaptation of British military rockets now under development to make possible all-British launchings of earth satellites, if this should be desired.

This is disclosed in a report to the COSPAR Meeting here by the British National Committee on Space Research. The report discusses in some detail space research activities in the United Kingdom in 1959. They fall into four categories: (1) Upper-atmosphere research with rockets. (2) Tracking, both optical and radio, of satellites and space probes. (3) Activities of the Satellite Prediction Service and World Data Centre C. (4) Design of scientific instruments for use in satellites, and design studies of methods whereby British rockets could be used to launch earth satellites.

• **Upper-atmosphere research**—The British contribution in this field has been developed jointly by the British National Committee on Space Research and the Ministry of Aviation, using the *Skylark* upper-atmosphere research rocket. This rocket is launched at Woomera in South Australia, by agreement with the Australian Department of Supply, and with the help and cooperation of the Woomera Rocket Range authorities.

A number of successful experiments were carried out during 1959, the following being the most important: University of Belfast: Measurements of upper-atmosphere winds and temperatures by observation of sodium clouds released from rockets; University of Birmingham: Use of positive ion spectrometers ejected from the rocket on a long cable, to record ion spectra at heights ranging from the lower ionosphere to approximately 150 km. The measurement of electron density by a dielectric method has detected a narrow sporadic 'E' layer at about 100 km altitude;

University College London: Data on upper-atmosphere winds and temperatures have been obtained from observations of grenade bursts. Solar Lyman radiation and solar X-rays have been monitored by nitric oxide ionization chambers and emulsion detectors. Langmuir probe equipment has been used to study sporadic E ionization, and electron and ion concentrations in the ionosphere;

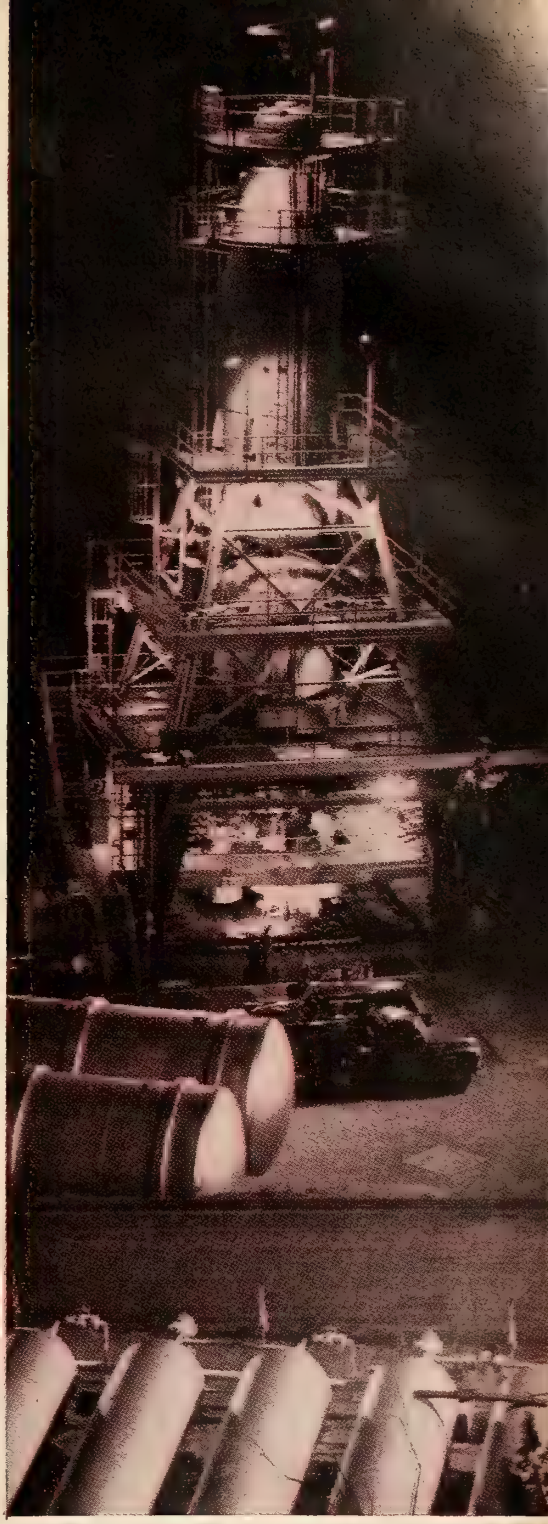
Imperial College London (Department of Meteorology): Observations, by radar, of the motion of clusters of resonant dipoles released from rockets have yielded data from which upper-atmosphere winds can be deduced; Imperial College London (Department of Physics): Variation of Cosmic Ray intensity with height above Woomera has been determined up to an altitude of some 700 km using a single Geiger Counter;

International Rocket Week 1959: Three *Skylark* rockets were prepared for launching during the week 16-22 November, 1959. Unsuitable weather delayed the firings, but all three were successfully launched on November 30th-December 1st. The results will be made available when analysis of the data has been completed. The main experiments carried out were: Observations of sodium vapour trail, giving wind and temperature data. Observations of grenade bursts, giving wind and temperature data. Observations of electron density, using a dielectric method. Observations of the drift of a cluster of resonant dipoles, giving wind data.

It is intended that the experimental programs of the groups already mentioned will be continued and widened during 1960. In addition, early firings concerned with measurements of the geomagnetic field, observations in the ultraviolet of the Southern Sky, and ionospheric investigations using propagation methods are planned.

• **Tracking of satellites and space probes**—The optical and radio tracking of satellites and space probes has continued. There are plans to extend the optical observations by kine theodolites or other instruments, in particular by distributing sites more widely so as to minimize bad weather limitations. The radio telescope at Jodrell Bank, near Manchester, has been used on a number of occasions to receive signals from both American and Russian space probes, and the Radio Research Station at Slough is extending its facilities for radio tracking.

• **World Data Center**—The World Data Center for rockets and satellites established at the Radio Research Station, Slough, in October, 1958, is fulfilling its intended purpose of collecting data on space research and exchanging it with the other two centers in Washington and Moscow. The flow of data is still relatively small and consists mainly of satellite positional observations, though reduced radio observations tables of orbital elements and ephemerides of certain satellites are also being received. The Center houses a large number of published and unpublished reports.



Typical test stand of Rocketdyne, a division of North American Aviation, Inc.

Textbooks Needed

Editor's Note: For some time, the editors of Missiles and Rockets have had a private astronautics correspondence school with a teenage Bombay space enthusiast. Our circulation setup does not permit the lad to buy the magazine, but one editor "slips" him a copy and occasionally he's sent technical textbooks which other publishers send us for review. Now's he's interested in finding a U.S. university where he could take mathematical astronautics courses by mail. We know of no university, but perhaps an M/R reader does. He says he's "very good" at differential and integral calculus, differential equations, etc. He adds he's "good" at thermodynamics, fluid flow and three-dimensional geometry. But he needs more text books on these subjects. Perhaps M/R readers will have some advice for him after reading these excerpts from his last letter:

". . . We (other youths) have decided to form a society (in Bombay) on Astronautics . . . I am glad to inform you that I am receiving a good amount of information and literature from NASA, and on atmospheric research through rockets, from Dr. Homer E. Newell, Jr. What nice and great people you Americans are. I feel worried when I hear of any rocket failures in your country and further wonder why is it that your country in spite of conducting heavy research in astronautics sometimes brings such unwanted failures? To be honest and frank, I would say that I was one of the happiest men in the world when the first *Explorer* was put into orbit. I was further not surprised when . . . the British Interplanetary Society recently mentioned that American satellites and probes have brought a considerable (greater) wealth of scientific information on outer space on a per pound basis than the USSR probes. Anyway I heartily wish for your country's to have major breakthroughs in space exploration in this new year . . ."

R. V. S. Mani
6/595, E, Mani Villa,
Vincent Rd. Matunga,
Bombay, 19, India

Another Pioneer

To the Editor:

I wish to join Vector Manufacturing Company, Inc. of Southampton, Pa., in the group of companies in the telemetering field which were *not* mentioned in your article, "What's Wrong in Telemetry," (M/R, 10/5/59).

Spectacular among these items is our transistorized oscillator which is smaller than a lump of sugar. We have also recently developed a transistorized transmitter with a radiated output of one-third of a watt; three miniature radio frequency power amplifiers which extend the power of the transmitter to as high as 100 watts; and a new electronic commutator which permits the transmitting of 25,000 data samples per second. We have two very small oscillators, one weighing only 1¾ ounces, the other disc-shaped, with a diameter of 2.6 inches and a thickness of 5/16 inch.

We pioneered this year a new concept of modular system integration which eliminates the chassis entirely, results in weight savings and costs and provides for more flexibility in the assembly of telemetry systems.

We developed in 1958 a completely transistorized phase lock discriminator. Its size is one-sixth that of the conventional tube type. It uses less power and generates almost no heat.

Stanley S. Wulc,
President, Vector Manufacturing Co., Inc.,
Southampton, Pa.

Mountain out of Molehill

To the Editor:

As a member of the California Historical Society, I am something more than mildly interested to learn that Cortez's protégé Gaspar de Portolá (and, later, Father Junipero Serra) was able to journey through the California coastal country on his explorations without discovering (or, if he did so, without making reference to) 21,500-foot Mt. Tranquillon, which you have pictured on page 17 of your fine Dec. 28 report on the Navy's Pt. Arguello facility.

As a member of the Sierra Club, I am happy to report to you that a team of climbers is even now sharpening its crampons for an assault on the previously unconquered slopes, faces and cols of this majestic escarpment. How thoroughly it dwarfs Mt. Whitney!

As a worker in the telemetry field, however, I am concerned about oxygen supplies for the chaps assigned to the tracking station, and arctic-type wearing apparel to protect them against what must undoubtedly be mighty cold weather at the snow-crested summit.

Carl Briggs
Los Angeles

M/R was awaiting comment on its upgrading (in a picture caption) of 2150-foot Mt. Tranquillon. (The correct height was given in the first sentence of the story.) Our apologies to Mt. Whitney (14,495 ft.), still California's, and the United States' tallest mountain. We think there was a gremlin—or an abysmally aberrant Abominable Snowman—on our copy desk. Anyhow, we think big!—Ed.

The Real Dynamos

To the Editor:

Congratulations for pointing out (in your Nov. 16 editorial) the one really dynamic force in the thought-to-be age of the industrial giant—the creative, fast-moving and uncluttered individuals who have founded the hundreds of small, pioneer-oriented companies.

Their credo of "Serving a Need" is possible only in the self-generated environment of the American Giants.

C. W. Reiniger
Sales Manager
Missile Products
Crosley Division
Avco Corporation
Cincinnati 25, Ohio

Teflon Resistivity

To the Editor:

It was a pleasure to see the excellent condensation (M/R, Jan. 4) of our technical paper on high temperature resistivity of wire constructions insulated with TFE resins.

For the record, should any of your readers desire a complete copy of this report, they are available, and I would be happy to handle such requests.

J. C. Reed
Polychemicals Department
Du Pont Company
Wilmington 98, Del.

Simplicity Called Key to Red Success

by an M/R Correspondent

STUTTGART, WEST GERMANY—A German rocket expert recently released by the Russians says the Soviets are ahead in the missile/space race because their scientists concentrated on a few rockets and vehicles, made them simple and rugged, and were free from outside pressure in their selection of components.

"The Soviets achieved (their lead) without the help of mysterious fuels or exotic metals," according to Dr. Helmut Gröttrup, who also said many Soviet feats were made possible by German brainpower—but not since 1950.

Gröttrup was captured by the Russians after World War II and put to work on their rocket program. He was recently permitted to return to Germany.

• **One at a time**—The main reason for Russia's successes, he claimed, was that her scientists developed only a small number of models; two missiles for the same basic purpose were never developed simultaneously, because a special committee was set up to prevent costly and diversionary competition.

"There never would be a *Thor* and a *Jupiter* in Russia," he declared.

• **Virtue of simplicity**—Russian missiles are much simpler in construction—and therefore more rugged—than U.S. birds, Gröttrup said. Far less attention is paid to miniaturization, and there is no need to stuff the bird with delicate instrumentation. As a result, Soviet missiles are more reliable.

Furthermore, he noted, Soviet rocket designers who wish to incorporate certain components into their "baby" do not have to respect the interests of various companies or individuals connected with the project—they simply choose the parts they consider best.

• **A little knowledge**—Gröttrup suggested another, paradoxical, reason for the frequent U.S. failures: American engineers have developed gyroscopic guidance apparatus of an accuracy long believed impossible to achieve, and thus created the prerequisites for inertial guidance. As a result, highly delicate instruments inside the rocket have been made responsible for its guidance.

In contrast, the telemetering systems chosen by the Russians are mainly based on the ground. Inside the rockets are merely several small, simple and very rugged instruments.

Gröttrup also labeled "insufficient" every U.S. launching in which the last stage of the rocket had to be spin-stabilized. "Without guidance of the last stage and without proper timing of burnout," he said, "the necessary flight accuracy can never be achieved!"

• **On their own**—According to Gröttrup, the German "Raketenkollektiv"—a group of scientists held prisoner by the Russians from 1945 until 1950—worked intensely on long-range rockets and designed several types of vehicles which were—compared to parallel developments in the U.S.—"incredibly advanced."

But he said that with the exception of guidance systems all Soviet developments after 1950—such as multistage rockets, new fuels and satellites—were achieved entirely by U.S.S.R. scientists.

west coast industry . . .

By FRANK G. McGUIRE

"Within five years, any company with all their eggs in the rocket business will be in serious trouble—just as the airframe manufacturers are today," Quote from Joseph W. Crosby, president of Thiokol Chemical Corporation. It makes very interesting reading, and Mr. Crosby's reason for his statement was just as interesting. The five-year estimate is a revision of his original belief that the situation described would occur within ten years, for the following cause:

"The very same factors that are forcing the airframe companies to go into such fields as electronics and shipbuilding will force rocket engine and propellant manufacturers to do the same type of thing. There will be many more companies in the field than business will support." In view of this belief of its president, Thiokol is planning an expansion into the industrial chemicals field, and will avoid placing all its eggs in the rocket basket.

Crosby frankly discussed many aspects of the firm's business, saying for instance that it had been a mistake to build a facility at Elkton, Md., because of inability to carry out necessary expansion at that site. He also stated that the job of management will be much tougher in the next five years. "I hope my successor does a better job than I have," he said, ignoring the fact that the stock market seems to disagree with this implication.

Thiokol, which entered the solid propellant field under Crosby's direction in 1947, now has ten plants scattered throughout the country. From its $5.9 million gross in 1949, the firm soared to $89 million gross in 1958. First-nine-months gross for 1959 was $127,883,796, while the like period in 1958 showed a $54,607,976 figure. Previously an Eastern company, Thiokol very shortly will headquarter all its rocket activities at its Utah facilities near Brigham City.

Merger of CEC with Bell and Howell . . .
is not a joining of two unlike organizations, as first glance may indicate. Consolidated Electrodynamics Corp. has been in information retrieval, data processing and conversion, while B&H has been active in graphic intelligence conversion and display. These will complement each other admirably, and may well give the partners a basis on which to bid jointly on future military contracts.

North American's 43,000 employes . . .
will get a two-cent-per-hour cost of living increase as of Jan. 24. The raise will bring to six cents the total cost of living raises gained by the employes.

Martin Company has set record straight . . .
on its last *Titan* explosion. Company has emphasized reliability of the relay involved, and says an undesirable location placed 250 g on the relay, which was designed for a maximum of 50 g. Relay has been relocated.

Packard-Bell has consolidated . . .
two divisions and a subsidiary into its new Defense and Industry Group, expanding the firm's operations in advanced military and industrial electronics. Comprising the new organization are the Technical Products Division, the Packard-Bell Computer Corp. (which has been operating as a division), and a subsidiary, the Technical Industries Corp. Head of the new group will be Richard B. Leng, formerly vice president of the Technical Products Division.

Narmco's acquisition by Telecomputing . . .
if approved by Narmco's shareholders, will result in a firm having well over $50 million annual sales. The merger, scheduled for completion around February, will involve 497,000 shares of TC common stock, which will be exchanged on a ratio of two shares of TC for one share of Narmco. TC's sales in the fiscal year ended Nov. 1 were $38,333,000, while Narmco's annual sales are running around $12,000,000.

Solar Aircraft may merge with IH . . .
if a proposed offer of stock is approved, on a basis of 2¼ shares of Solar stock for each share of International Harvester common. IH has filed a registration statement with SEC for the 266,064 shares of its stock involved.

Advertisers' Index

reviews

THE SPACE DIARY, 1960, Compiled by L. J. Carter Esq., A.C.I.S., Secretary, The British Interplanetary Society, T. J. & J. Smith, Ltd., London, W.I. 180 pp.

The author—well known in international astronautics—has compiled a handy pocket diary which should serve as fingertip information on astronautics.

The diary originally was designed for children, until English newspapers commented that more than 25% of its contents were unknown to 95% of adults. Result: Title was quickly altered.

In addition to regular diary space for late notations, it contains a glossary on astronautics, background information on the B.I.S. and International Astronautical Federation, and facts and figures on astronomy, propulsion, rocket structure, satellites and tracking.

SOME NOTES ON MATHEMATICS AND MATHEMATICIANS IN THE SOVIET UNION, a preliminary study by Warren B. Walsh, Chairman of the Board of Russian Studies, Syracuse University, Syracuse 10, N.Y.

This study has found the United States superior to the U.S.S.R. in mathematics generally, but this must be qualified in terms of fields.

The Soviets are currently in the lead in analysis; in the theory of control circuits; in the branch of geometry dealing with convex figures, and perhaps in the field of topology.

The report has found they are at least on a par with the United States in probability, partial differential equations, differential equations, applied mathematics, and number theory as a whole. They lag somewhat behind in mathematical logic, modern algebra, algebraic geometry, and geometry as a whole.

THERMOELECTRICITY ABSTRACTS. Two volumes. Order PB 151657, 112 pp. $2.50 and PB 151810, 81 pp. $2.25 from Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

References to the literature on research, development, and application of thermoelectricity accumulated by the Library of the U.S. Naval Research Laboratory, are contained in these two volumes.

The bibliography shows abstracts of unclassified literature on thermoelectricity gained from abstract journals, indexes, and bibliographies. Early and recent material is included.

HEAT CAPACITY DETERMINATION OF MINERAL AND SYNTHETIC ENGINE OILS, LUBRICANTS, FUELS, AND HYDRAULIC FLUIDS IN THE TEMPERATURE RANGE 70-500F. T. M. Medved, C. C. Bolze, C. E. Hansen, and J. W. Barger, Midwest Research Institute for WADC. Order PB 161030 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 64 pp. $1.75.

Heat capacities are reported for 33 mineral and synthetic engine oils, lubricants, fuels, and hydraulic fluids at 80,-185,290,393 and 500°F.

Calorimeter constants were obtained by internal standardization, eliminating use of standard liquid. A comparison of latent heats of vaporization of phenyl ether samples is included.

The work is a continuation of that described in an initial report, PB 151210, available from OTS for $1.25.

Used together, the two reports describe the unique, simple, rapid method used for measuring and calculating heat capacities over a wide temperature range.

DETONATION INDUCTION DISTANCES IN COMBUSTIBLE GASEOUS MIXTURES AT ATMOSPHERIC AND ELEVATED INITIAL PRESSURE: I METHANE OXYGEN, II CARBON MONOXIDE OXYGEN, III HYDROGEN OXYGEN, L. E. Bollinger, and R. F. Edse, The Ohio State University for WADC. Order PB 151873 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 98 pp. $2.25.

Intended to collect data to aid rocket designers, this study determined the effect of initial pressure on detonation induction distances of various methane-oxygen and carbon monoxide-oxygen mixtures.

In addition, the effect of tube diamter for hydrogen-oxygen mixtures was determined for two values of diameter at an initial pressure of one atmosphere.

One conclusion was that the induction distance decreases with increasing initial pressure for all fuel concentration studied. However, the decrease in length with increasing pressure inversely follows the variation of burning velocity with pressure.

RAPID SEPARATION AND GRAVIMETRIC DETERMINATION OF ALUMINUM IN FERROUS METALS, L. A. Keyser and C. D. Houston, WADC, USAF. Order PB161003 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. $.50.

A rapid method for separating iron and aluminum was developed.

The technique is useful for analyzing aluminum in ferrous metals in the absence of nickel. Separation is achieved by the sodium hydroxide method. Aluminum is precipitated with 8-hydroxyquinoline and determined gravimetrically.

MASTER RECEIVING-PICTURE TUBE SUBSTITUTION GUIDEBOOK, H. S. Middleton. John F. Rider Publisher, Inc. New York, N.Y. 352 pp. $7.45.

The engineer frequently has occasion to substitute one tube type for another. Most tube types have equivalents in other tube types, but they are not always excellent substitutions.

This book covers 5100 American receiving tube substitutions; 825 American made TV picture tube substitutions, as well as 325 American-European receiving tube equivalents and almost the same number of European-American receiving tube equivalents.

editorial . . .

Space Gets a Crust From New Budget

The President's space budget for Fiscal 1961 will be a bitter disappointment to the many people in this country who hoped it would provide sufficient funds for something more than the lackadiasical program it promises.

In his message Mr. Eisenhower says:

"The National Aeronautics and Space Administration is carrying forward the nonmilitary space projects started by the Department of Defense and has initiated additional programs that will lay the foundations for future exploration and use of outer space. Estimated expenditures of $600 million during the fiscal year 1961, nearly double the expenditures in 1960, will carry forward the programs now under way and those becoming the agency's responsibility in 1961."

This is literally "double talk." Far from "doubling" the 1960 program, the 1961 adjusted expenditures actually will only increase last year's program by one fourth.

Last year's NASA R&D money was $370 million. This year's is $634 million. But that $634 million includes $139.5 million transferred from the Defense Department for the development of the clustered booster, *Saturn*—a project NASA did not fund last year. So, in reality, NASA's spending (in addition to *Saturn*) will total only $495.5 million. This is an increase of $125.5 million—or only about 25%—over $370 million.

This fact is further emphasized by the fact that the 1961 program of space projects is just about the same as that in 1960. They may be somewhat more sophisticated, a little more costly, somewhat more advanced (they should be) but numerically they add up almost the same.

In major space probes we will have four. In FY 1960 we had three.

In scientific satellites we will have eight. In 1960 we had seven.

Worse, no back-up is provided in the budget for any of the twelve projects. If one of the four space probes fails it will simply fail, and its objectives will be carried forward to the next probe —three months or so later—if they can be included. The same is true of the satellites.

NASA officials feel that the program is designed to give the nation's space scientists a lot of information and that it will advance our space knowledge along the broad technological front.

But—they make no pretense that this is a program designed to compete with the Russians. They are obviously not enthusiastic about its extent. They do not say that the limitations are of their setting. They admit they could "do a lot more."

The President has sent a letter to Congress suggesting changes in the National Space Act—changes which have been advocated on this page. The changes he suggests are three-fold: that he be relieved as project officer for the space program; that the National Space Council be abolished; that the Military Liaison Committee be likewise abolished.

He suggests that this will leave the Department of Defense in charge of military space activities and NASA in charge of scientific or peaceful—i.e., space—exploration.

These are steps in the right direction—management steps. But, we submit, no amendments to laws and no shifts of management will amount to a tinker's damn until we have recognition at the top level—meaning Mr. Eisenhower—of the tremendous political and psychological importance of the U.S. space program in international prestige and national survival.

CLARKE NEWLON

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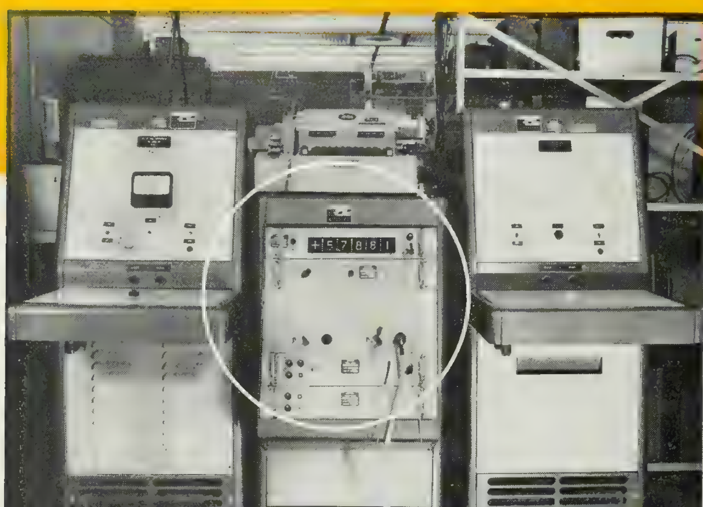
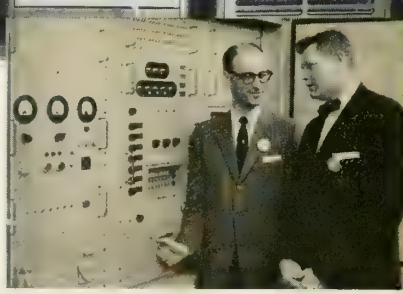


Digital read-out sub-system of a large, automatic, transistor production checkout system.



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FUEL FOUNTAIN—TESTING ATLAS MIX

missiles and rockets

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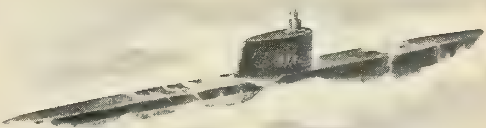

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Missiles and Rockets Volume 6 Number 5

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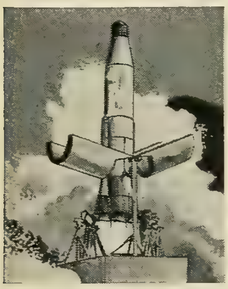
COVER: Fountain from 300 water tubes at Rocketdyne test lab provides visual check on distribution of RP-1 fuel used to cool thrust chamber of *Atlas* ICBM booster engine.

RETIRED chief of Army Ordnance Missile Command, Maj. Gen. John B. Medaris blasts the Administration's space policies and calls for abolishment of NASA in exclusive interview with M/R. Turn to p. 12.



STORABLE *ATLAS* blasts off in M/R artist's conception. The Air Force is studying a Convair proposal for a completely storable *Atlas*. See story on p. 14.

PRE-TEST checkout of experimental ion engine is conducted at WADC's Propulsion Lab. Electro-Optical Systems Inc. has won contract for first ion engine for space. See p. 24.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

30,200 copies this issue

FEBRUARY 1 HEADLINES

ASTRONAUTICS ENGINEERING
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ASTRIONICS

NEW MISSILE PRODUCTS

THE MISSILE WEEK
U.S. Reg. Pdg.

DEPARTMENTS


YOU'RE
ON THE
INSIDE . . .

Washington Countdown

IN THE PENTAGON

Contracts on *Missile A* . . .
for development of test models are scheduled to be let soon by the Army. Some six firms will be awarded contracts for development of components that will be integrated by the Army Rocket & Guided Missile Agency.

• • •

Little doves . . .
are hampering missile test operations at Holloman AFB, N.M. They perch on the rails of the 35,000-foot captive missile test track and pack a powerful wallop when hit by a speeding missile.

• • •

Big boosters . . .
of the class of *Saturn* and *Nova* still interest the Pentagon only vaguely despite the Soviet Pacific tests. The reason: The Administration continues to insist that the military has no foreseeable mission in space beyond a few thousand miles out.

• • •

Some 400 *Hound Dogs* . . .
at the most, plus spares, are expected to comprise the stockpile now planned by the end of 1962. All 14 B-52 bomber wings will have the North American air-to-surface missiles. But not all B-52's will be armed with them.

• • •

More budget breakouts . . .
from total missile procurement figures for FY 1961:

. . . $170 million will be spent on the *Hound Dog.*

. . . $421.5 million will be spent on the Boeing *Bomarc-B.*

. . . $111.4 will be spent on the Western Electric *Nike-Hercules.*

> In the Industry and Military argot of Washington, the "mumble meeting" and the "no purpose conference" have long been well known. To them recently was added a new phrase—the "dither index." Its appearance coincided with the normally-almost-incomprehensible national budget.

ON CAPITOL HILL

Widespread howls . . .
will be heard from the halls of Congress when the still-classified GAO report on Air Force missile management is released—probably within the next month. The report:

. . . Hits at Air Force operations involving the Ballistic Missile Division and Space Technology Laboratories.

. . . Charges tax money was wasted because of Air Force refusal to disclose information to Congress.

• • •

The suppressed book . . .
written by SAC Commander Thomas Power is attracting renewed attention in the current debate over the Missile Gap. Several committees are taking a new look at just why Power's book came under the official Pentagon ban.

AT NASA

Italian Somaliland . . .
is understood to have been offered NASA as a possible spot for constructing an equatorial launching site. The pad complex would be located near Kisimaio. The launchings would take place eastward down an island-dotted 7200-mile sea range.

• • •

The first *Scout* launching . . .
now is expected about June. The *Scout* launching pad under construction at Wallops Island, Va., is about 80% completed.

• • •

The last *Little Joe* test . . .
which will have McDonnell's *Mercury* capsule on top, is scheduled for March. The last preliminary shot is scheduled for next month.

INTERNATIONAL

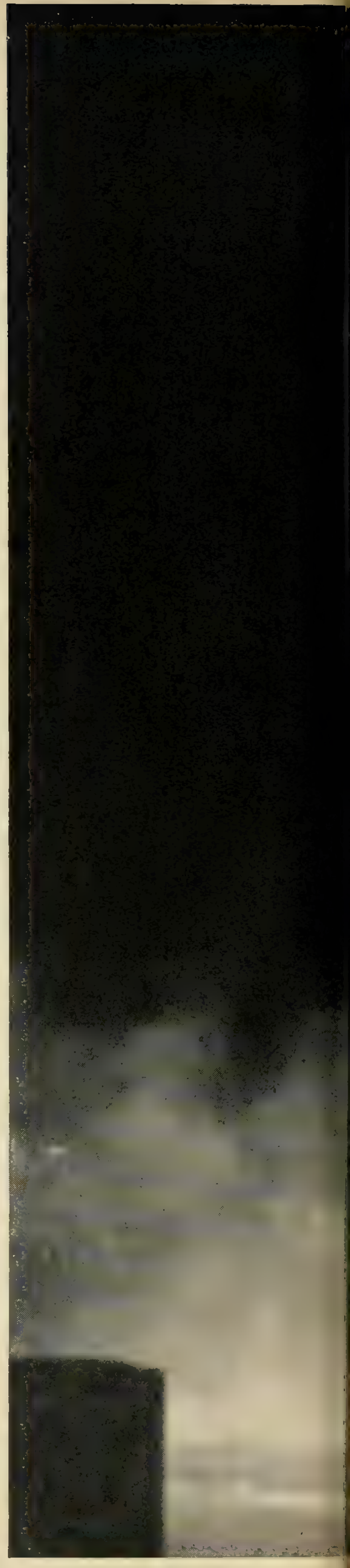
The Soviet *Komet D* . . .
an air-to-surface tactical missile, is reported to have reached the advanced testing stage. The nuclear-tipped turbojet missile is understood to be 33.46 feet long and 3.96 feet in diameter.

• • •

French *Nike* trainees . . .
picked to man a second French *Nike-Ajax* base are scheduled to arrive in the United States this year for basic training. Classes are expected to be at Ft. Sill, Okla.

• • •

Soviet A-subs . . .
are reported under development at shipyards in 11 cities—Molotow, Severodminsk, Ischensk-Kolpino, Leningrad, Reval, Riga, Kolomna, Gorki, Odessa, Nikolajew and Sevastopol. The first of the Russian nuclear-powered submarines is understood to be undergoing sea tests.



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Industry Countdown

MANUFACTURING

Now coming off production . . .
lines at MATRA of France is the two-stage, 395-lb. *R-511* air-to-air-missile. Equipped with either IR or electromagnetic homing guidance, the *R-511* is powered by a solid Hotchkiss-Brandt engine and will be used aboard Vautour, Super Mystere and Mirage III aircraft.

• • •

East's first *Atlas* . . .
ICBM base will be at Plattsburgh AFB, N.Y., about 250 miles north of New York City. The Air Force also will put *Atlas* squadrons at Altus AFB, Okla.; Dyess AFB, Abilene, Tex., and at Walker AFB, Roswell, N.M. Each of these four new squadrons will contain nine missile launchers, located in underground complexes of three dispersed within a 35-mile radius of the AF bases. The four ICBM bases will cost $47 million apiece. This makes 10 *Atlas* bases designated so far; a total of 13 are planned.

• • •

Hardening of *Bomarc* . . .
interceptor missile bases is out. DOD officials say putting *Bomarc B* launchers underground would only delay making them operational.

PROPULSION

Sectional technique . . .
for fabricating multi-meg solid rocket boosters at the factory and then assembling them at launch site has been developed by United Aircraft's United Research Corp. The company, which has signed patent applications, believes its approach will cut costs greatly by eliminating logistic problem of on-site loading.

• • •

After switch to storables . . .
the Martin *Titan* ICBM probably won't be used as a space booster. The Air Force says it is interested in *Titan*—as well as *Atlas*—primarily as a weapon. Both ICBM's are expected to be in service through 1970.

• • •

System for recording . . .
all shock and temperature change damage to a solid motor from factory to time of launching has been developed by Avien Inc. Details are classified, but the company claims the test device is simple, reliable and fast.

ASTRIONICS

***Minuteman* guidance . . .**
system being developed by Autonetics is undergoing tests up to 10 g aboard a Mach 2 sled at Holloman AFB. The Aerojet-General sled is propelled by a three-chamber liquid propulsion system developing 114,000 lbs. of thrust.

• • •

Rash of orders . . .
for electronic instrumentation equipment has followed the Russian launch of a missile into the Pacific. Some manufacturers reportedly are swamped with work and are wondering if the U.S. is going to instrument the Soviet range.

• • •

Major companies . . .
are closely watching the expansion plans of potential subcontractors—particularly in the electronics field. Some feel they should shy away from awarding contracts to firms which are growing too fast. Reason: management and talent may be spread too thin to guarantee a reliable product.

WE HEAR THAT

Japan plans to make . . .
Sidewinder air-to-air missiles at $500 per unit. (Price of European-made *Sidewinders* has been quoted at $3000 to $4000) . . . Republic Aviation is scotching rumors of a 2000-man layoff. Officials say big buy of F-105's in the FY 1961 budget insures employment stability for foreseeable future . . . Bids are due at the end of February on the second stage of the NASA-ABMA *Saturn* vehicle . . . The German Rocket Society is setting up a training center and manufacturing facility at Bremen with the help of $35,000 in donations from German industrial firms . . . Germany's Focke-Wulf is negotiating an agreement with Short Brothers and Harland of England for test and possible procurement of the surface-to-air *Seacat* . . . the *Sky Dart* has been selected as the primary target drone for the missile competition at Nellis AFB in July.

an M/R exclusive . . .

Medaris Retires with Blast at NASA

Would abolish civilian agency and give space/missile job to joint military command; says U.S. is 'second-rate' space power now, USSR may be dominant by 1970

by James Baar

HUNTSVILLE, ALA.—Maj. Gen. John B. Medaris, chief of the Army Ordnance Missile Command, retired this week with a lashing attack on the Administration's space policies and a call for the abolishment of NASA.

In phrases as clipped and well-groomed as his usual appearance, the general:

• Raked the civilian-military separation of U.S. space programs as "fundamentally unrealistic" and called for creation of a single missile-space agency—a joint military command.

• Charged that the Administration's unchanging "reluctant dragon" attitude toward space is leading to disaster.

• Brushed aside as "utter nonsense" the contention of President Eisenhower and other Administration officials that the Armed Forces have no business in exploring space.

• Warned anew that America must develop huge boosters as quickly as possible or find itself "out of the race" with Russia.

Medaris opened up on the Administration in an interview in the office here from which he had directed most of America's first successful space efforts. His statements appeared to be a preview of what he will say later this month when, freed from the restraints of being on active duty, he is scheduled to testify before the House and Senate Space Committees.

"The next 10 years will set the pace for a long time to come in this world," Medaris said. "One of three things has to happen in the '60's."

• One—"We can be so far outdistanced in missiles and space that we will become a second-rate power with all the consequences that will mean to the Free World and the integrity of man."

• Two—"We can achieve parity (at least) with Russia with the consequent ability to hold our position."

• Three—"The Millenium is going to arrive and the lion and lamb will lie down together in peace."

Medaris paused; then he added pointedly:

"If the second isn't achieved, the third is unlikely."

The 57-year-old general said the Russians with their "present start" can achieve domination of the moon and cislunar space by 1970 "if there is nothing around to interfere with them."

He said if that happens "the threat will be very considerable" and the United States won't be able to do much about it.

"Unfortunately we already are second-rate in space," he said. "No one will even argue that point anymore."

Medaris sat at his large desk and smoked cigarettes. Behind him stood his personal two-star flag and an Army flag resplendent with battle ribbons.

Occasionally as he talked, Medaris got up and paced around the room. He wore his decorations on a well-cut uniform. His hair and mustache were carefully cut.

• **Pull ourselves together**—"We can't do this thing correctly and with full efficiency unless we get all of it together someplace," he said. "You can't separate missiles from space and you can't separate military space from civilian space with a technology that is all part of the same thing and that is moving so rapidly on so many fronts.

"In a single organization it is not too difficult to get anything of any importance to the top. Everyone shares information. You can move ahead with your successes. And you don't have to make the same mistakes twice."

Medaris said there is only one place to put together a single agency—inside the Pentagon as a joint command.

"The services must develop the new weapons and only the services have the vast support and other facilities that are needed," he said. "The services are as interested as the scientists in advancing space exploration because they know that any new piece of information can have military value.

"The only excuse for NASA was to take projects from the competitive area. But a joint command would do the same thing."

He said under a Joint Missile-Space Command "the arguments between the services would be settled before the projects began, instead of having them go on all through the life of a system."

Medaris smiled thinly.

"The trend, of course, is going the other way," he said. "I seem to hold a minority opinion."

• **Root of the trouble**—Then he returned again to the Administration's basic attitude.

"Here's the fundamental question," he said. "We were dragged into this space business from the beginning and we still act that way. We ought to be in this argument. But, instead, we're still half-way in and half-way out."

Medaris smiled again, but his expression made clear that he didn't see anything very funny at all.

Maj. Gen. John B. Medaris is stepping down as chief of the Army Ordnance Missile Command and retiring from the Army almost two years to the day since the launching of America's first satellite and four years since he assumed command of the then newly-established Army Ballistic Missile Agency.

ABMA officially opened for business Feb. 1, 1956.

ABMA's Explorer I *was launched into orbit Jan. 31, 1958.*

MAJ. GEN. John B. Medaris stands before giant Saturn static test stand at Huntsville in this picture taken a few days before retirement. He is holding a *Nike-Zeus* model. In the background are other Army missiles.

AF Gets Plans for Storable *Atlas*

Fully loaded ICBM's would be hard-based and ready to go. Proposal expected to touch off another round of debate between Titan/Atlas

by Frank G. McGuire

LOS ANGELES—Plans for a completely storable *Atlas* ICBM which would require no changes in fuel or missile design have been handed to the Air Force by Convair, MISSILES AND ROCKETS has learned.

The proposal—said to be less expensive than present plans to insure a short reaction time for the missile—is now under study. The Air Force says, however, that a storable *Atlas* "is not presently programmed."

Under the Convair proposal, all *Atlas* missiles would be hard-based in underground silos, complete with propellant. Each would be equipped with a clamshell device embracing the liquid oxygen tank area in a blanket of insulating materials.

Such a system would be effective for extended periods of time, the proposal says, due to the extremely low LOX boil-off experienced with the insulation method.

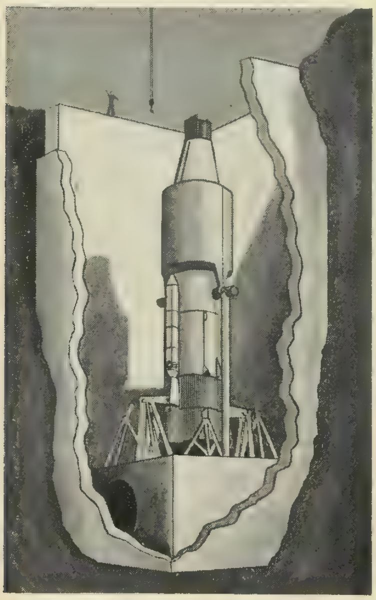
The company is believed to have solved problems involved in such a scheme. One cost advantage is that it would eliminate the need for expensive high-speed propellant-loading equipment. Convair has conducted extensive tests to evaluate the effects of such long-term cold storage on valves and pumps in the missile. These have shown a stabilization of materials after about 15 minutes exposure to LOX. After this initial period, reaction to the exposure levels off.

• **Two-hour hold**—It is pointed out that missiles have been launched after a hold of as much as two hours on the pad, and that other tests have been conducted for over 24 hours, with no detrimental effects on valves and other components.

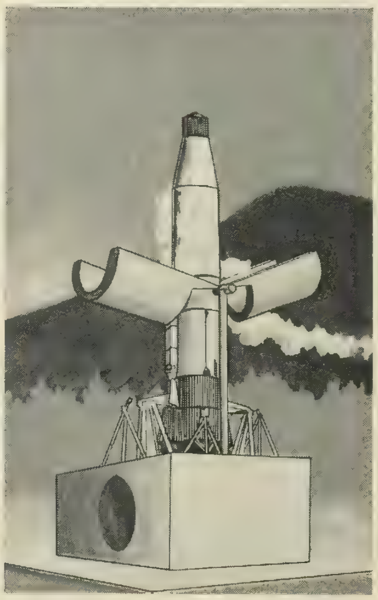
The insulation proposed for use with the clamshill device is a Stryofoam material, augmented by circulating liquid nitrogen. In addition to the clamshell unit, a cryogenerator would be needed to replace boiled-off nitrogen.

• **Further discussion**—News of the storable *Atlas* proposal is expected to touch off another round in the bitter debate between *Atlas* and *Titan* supporters. Martin Company favors an early switch of *Titan* to storable fuels (nitrogen tetroxide/UDMH-hydrazine). But the *Atlas* plan, its backers assert, would give the Convair missiles all the advantages of a storable *Titan*, without

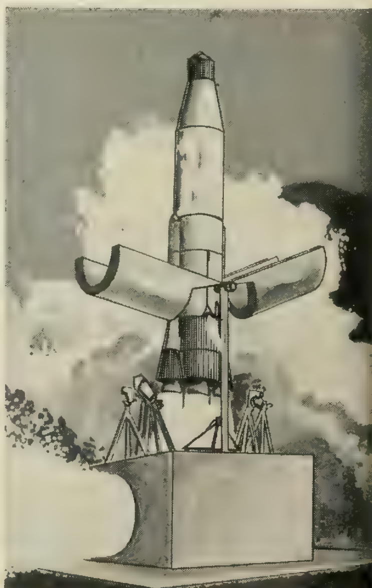
stored . . .



ready . . .



going . . .



CONVAIR'S STORABLE *Atlas* would have a clamshell insulator of liquid nitrogen and styrofoam to embrace the LOX tank and curtail boil-off. Elevator would raise bird and shell above ground for firing. Each silo would be hardened.

requiring costly modification of the missile itself.

Atlas proponents charge that the *Titan* conversion will cost as much as $200 million and require hundreds of full-duration engine firings for qualification. An Air Force source says the number of engine firings required to check out a storable *Titan* might be as high as 700. Queried by M/R, Martin Co. refused comment on costs of the conversion.

Denser nature of the non-cryogenic storable fuels for *Titan* will require structural modification of the missile to take the extra weight. An Air Force spokesman, queried on this, said the necessary modifications would be "substantial." An up-rated Aerojet-General engine is expected to be available, however, to provide necessary additional thrust. "But the result," pro-*Atlas* people say, "is a completely new missile . . . and since this is not required, why spend the money for it?".

The nature of the N_2O_4/N_2H_4-UDMH propellant combination would nominally limit the *Titan* to 80% of its tank capacity before a structural beef-up would be required. However, so many engineering factors enter the picture that this cannot be considered an unbreakable limit. Only the missile designer could determine the actual load limit imposed by denser fuels in a unmodified tank structure.

Present Air Force plans call for non-storable *Titans* in the first six squadrons. Conversion would begin with the seventh of 14 programmed squadrons, if maximum savings are to be realized, the Air Force maintains.

• **Keyed to Congress?**—The Air Force, as well as *Titan*, came in for some sharp attacks during M/R's roundup of military and industry opinion of both the *Atlas* storable proposal and the plans for conversion of *Titan* until after budget hearings by Congress.

The implication is that Congress, considering the expense, might strongly challenge the need for the *Titan* conversion. This, in turn, would eliminate a strong argument for *Titan* itself. The need for *Titan* already is expected to be a subject of Congressional investigation.

Martin advocates point out that the clamshell system proposed by Convair could be adapted for *Titan*, although it would be somewhat more complex due to the need for insulating LOX tanks in both stages of the *Titan*.

Martin believes, however, that its proposed change to new propellants would result in a more effective and less complicated weapon system—even allowing for a more extensive modification of the missile.

Large R&D Contract for Douglas ALBM Expected Soon

Program before DOD for final review. Large production contract to follow with use on B-52 and other aircraft

by William J. Coughlin

Announcement of a large-scale research and development contract for the Douglas Aircraft Co. *GAM-87A* air-launched ballistic missile program is expected shortly.

Backed strongly by the Air Force, the program now is before the Department of Defense for final review. Scheduling of the program calls for the R&D contract to be followed by a large production contract.

The ALBM program, mating the Douglas-produced missile with the Boeing B-52 bomber, will provide Strategic Air Command with a new missile capability similar in strategy to that of the Navy *Polaris* program but—the Air Force believes—more flexible.

Douglas was awarded a sizable six-month study contract for *GAM-87* last May: it has since been extended. The award followed an industry-wide competition entered by some 20 firms.

GAM-87A, known as the *Sky Bolt*, is a two-stage solid-propellant hypersonic missile with astro-inertial guidance. Range is 1000-1500 mi. Re-entry speed at 1000 mi.-range is about 10,000 ft./sec., about half that of an IRBM. A B-52, with only slight modification, much of it common to the North American GAM-77 *Hound Dog* program, can carry two or more *Sky Bolts*.

• **One of the last**—Award of the *GAM-87* contract is expected to be one of the last large contracts in the current missile program. It will, in fact, take the largest portion of Air Force R&D funds in the Fiscal 1961 budget.

Douglas is developing missile airframe and rocket engine casings. Aerojet-General Corp. is subcontractor on the propulsion system, providing engines and propellant as well as a large part of the design of the missile. General Electric is subcontractor on the re-entry body and Nortronics on guidance. Boeing Airplane Co. is an associate contractor.

Much of the effort under the study contract has gone into guidance. At the ranges contemplated, other portions of the program are well within the current state of the art and even the missile-borne portion of the guidance system does not represent any considerable problem. Accuracy required of the final-stage guidance system is less than that now required of an IRBM.

While second-stage guidance is the most critical from an on-target standpoint, the programmed first stage also carries some additional guidance. Most difficult development problem is that of the Nortronics computer system carried by the B-52, a system somewhat more complex than the submarine position-computing system for the *Polaris* program. Not only must position be computed more rapidly but speed of the aircraft at launch becomes a factor.

Nortronics already is building facilities and hiring additional engineers required in the large-scale program. While this is the firm's first contract on ballistic missile guidance, it had considerable success in development of the Mark I star-tracking system for the air-breathing *Snark*.

Northrop also has carried out development work on the A-8 interplanetary star-tracking system and the A-5 star-tracking system. In addition, it has done work on inertial systems. It is thus in a position to be familiar with astro-inertial systems, a combination of the two.

Douglas, with missile airframe design and production experience in the *Thor* program, has built test hardware for the *Sky Bolt* and conducted an extensive wind tunnel test program. No launch hardware has been built.

• **"Whole new realm"**—Gen. Thomas D. White, Air Force Chief of Staff, said recently that prototype tests have proved that a *Sky Bolt* can be launched from aircraft at both subsonic and supersonic speeds. This presumably was a reference to the *Bold Orion* program, from which much *Sky Bolt* data was obtained.

"The advent of long-range air-to-surface weapons launched from aircraft presents us with a whole new

realm of possibilities," Gen. White stated.

Strong Air Force backing for the *Hound Dog* and *Sky Bolt* programs stems from the additional weapons life which they will provide for the manned bomber, in which SAC has a considerable investment.

Air Force believes the air-launched ballistic missiles will provide a flexibility for the manned bombers which will outmatch that of the *Polaris* submarines, while not requiring the expensive initial investment in an entirely new weapon system. Both will be able to lob ballistic missiles at the enemy from outside his defense perimeter and from positions which he cannot predetermine.

• **Low budget item**—Launch platforms for the *Sky Bolt*—the B-52—already exist in large operational numbers while those for the *Polaris*, the nuclear-powered submarines, do not.

For this reason, funding proposed for the ALBM program is considerably less than that for the *Polaris*, *Atlas*, *Titan* or *Minuteman* programs.

Obviously, ALBM-equipped B-52's will be less restricted than *Polaris* submarines in their approach to Soviet frontiers. In addition, the B-52's cannot only fire their missiles from beyond the perimeter defense system, as could the submarines, they also will be able to penetrate the homeland itself.

A major advantage possessed by the air-launched missile in contrast to missiles such as the *Atlas*, *Titan* and *Minuteman* is that of "recall-ability," it is pointed out.

An air-alert of ALBM-equipped bombers avoids the vulnerability of hard-based ICBM's, proponents of the system note. "What you really need is inevitable response, not instantaneous response," one says. "The ALBM provides that."

Bases of ALBM aircraft are, of course, more vulnerable than the *Polaris* submarines or the hard bases of ICBMs. But this danger can be somewhat lessened by worldwide dispersal.

The proposal to mate the ALBM with a nuclear-powered aircraft in later stages of the program reduces this danger even further.

Need for an ALBM has been questioned in some quarters in the light of the development of an extended-range *GAM-77 Hound Dog*. In answer to this it is noted that intercept of a ballistic missile is considerably more difficult than that of a Mach 3 jet-powered missile or of a low-altitude device such as those being developed under projects SLAM and CLAM.

• **Ready for go-ahead**—Douglas' work on the *GAM-87* program has reached the point where the company is ready to undertake a full-scale development program. Due to the high level of funding of the study contract, it has been possible to take the missile to an advanced design stage and bring subcontractors into the program in considerable depth.

Major subcontractors also have been enabled to carry out their own subcontracting arrangements. Although contractually the other major firms in the program are subcontractors, their position has been more that of associates in a system integration. This has enabled them to contribute to the design program to a greater extent than normal under a study contract.

Douglas *GAM-87A* program manager is John Gorgenson, who coordinates the weapon system office with such activities as purchasing, inspection and manufacturing to provide overall company support. Chief project engineer is John Solvason.

Air Force management of the program rests with the *GAM-87A* weapon system office composed of personnel from the Air Research and Development Command directorate of system management and the Air Materiel Command aeronautical systems center, both at Wright-Patterson Air Force Base, Ohio.

'Built-in' Damping Developed

High-frequency structural vibrations, a prime contributor to low electronics reliability in space vehicles, can be reduced to a new low by building the damping characteristics right into the fabricating material.

Engineers at Barry Controls, Inc., Watertown, Mass., have come up with "Rigidamp," a process of incorporating a viscoelastic damping medium into ordinary structural materials. The development is based on a theory of optimum damping formulated by J. E. Ruzicka and R. D. Cavanaugh at Barry.

Sheets and thin rectangular section beams are laminated of conventional metals or plastics separated by a layer of the damping medium. I-beams, channels and angles are cellular rather than laminar. Longitudinal cells are formed throughout the length of the member. Each cell contains an insert separated from the walls by the damping medium.

The usual resonant responses of "Rigidamp" structures range from 5 to 10 times the excitation vibration throughout the frequency range encountered in current-environments. This is in comparison with conventional structures which respond with am amplication from 60 to 300 times the excitation vibrations, based on the nature of the material and its vibration input.

Barry spokesmen say that this is the first practical application of the inherent damping theory in which all portions of the structure act as load-carrying members and structures are designed for virtually optimum damping characteristics in all of the frequencies normally present in modern dynamic environments.

• **Longer life**—In addition to reducing the damaging vibrations to sensitive components, "Rigidamp" is expected to substantially increase the fatigue life of the structure. Barry damped materials have exhibited an extremely flat vibration response up to 2000 cps.—and in most cases this can be extended.

The damped structure will have a slightly smaller load-carrying capability than its conventional cousin. A slight increase in weight will be necessary to attain identical stiffness. But Barry scientists point out that there are many instances where structural designs are based on dynamic stress levels and it is possible that no weight increase would be necessary in view of the built-in damping qualities.

J. E. Ruzicka explained that the concept involves the design of specific structural configurations with sufficient damping incorporated therein to produce a maximum effect.

The nature of the damping viscoelastic medium was not revealed by the company. Ruzicka indicated that the medium has adhesive qualities but it must also exhibit certain ranges of viscosity and shear effects in order to function as an effective damper.

Barry Controls has several types of damped structures in production. The firm has supplied a stable platform for the Air Force's *Bomarc* missile.

Brazing Chamber Slashes Honeycomb Production Time

A new brazing chamber turns out stainless honeycomb panels in 30 minutes instead of the 23-hour cycle required by conventional furnaces.

Developed by Rohr Aircraft Corp. engineers at Chula Vista, Calif., the patented chamber contains a graphite cloth heating element devised by the National Carbon Company, a division of Union Carbide.

The chamber can heat panels to 1680°F in as little as three minutes. Various sized panels have shown uniform braze quality.

Another Success for *Little Joe*

by C. Paul Means

The fourth of six *Little Joe* tests launched last week at Wallops Island was completely successful, giving credence to the prospect that the final test with the McDonnell Project *Mercury* capsule on top is not far off.

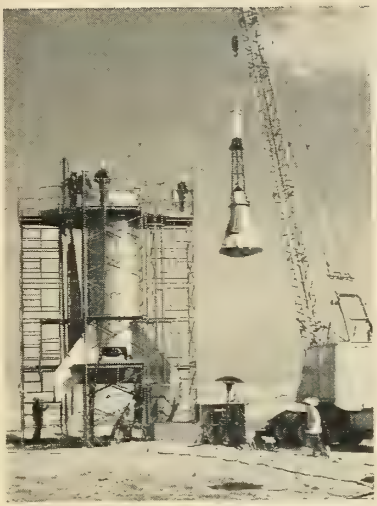
Also successful was the Air Force's School of Aviation Medicine's monkey test—not a part of Project *Mercury*—which was conducted on a space-available basis.

Purpose of last week's test was to study the functioning of the escape system and the aerodynamic stability of the capsule under a maximum "Q" abort situation.

In an era when most U.S. space programs have been marked by launch failures and delay, the *Little Joe* program has progressed like clockwork since the program's first hair-raising experience (when the capsule's escape rockets prematurely fired, lifting it into the air and leaving the booster behind). Since then, successful launches have occurred on Oct. 4, Nov. 4, Dec. 4 and Jan. 26.

The boiler-plate capsule launched last week was lifted by two Pollux and four *Recruit* solid rocket motors produced by Thiokol. The final version of *Little Joe* also uses Thiokol's *Castor* motor.

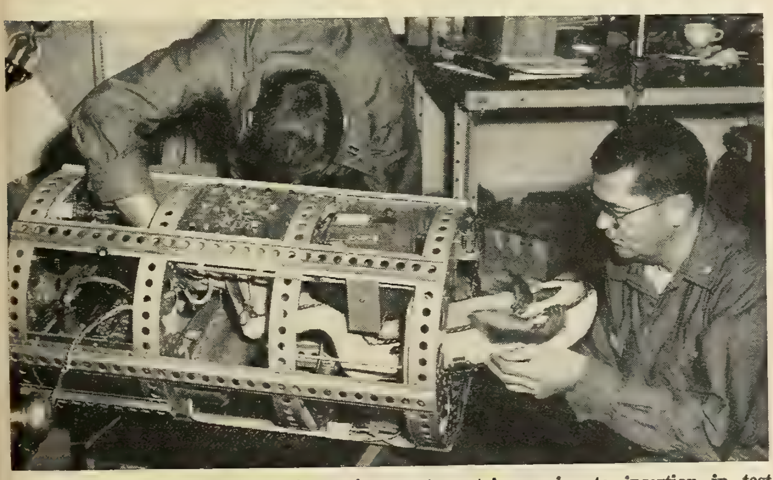
When the booster had lifted the capsule to an altitude of 36,500 ft., the Grand Central Rocket escape system ignited and burned for about one second, lifting the capsule away from the booster at the rate of 200 ft. per sec. to an altitude of 48,900 feet.



TECHNICIANS hoist capsule atop the fourth *Little Joe* booster at Wallops.

The monkey and capsule were subjected to 9 g at launch and to a peak of 19 g at separation.

• **Back after launch**—At the top of the trajectory, the tower was automatically jettisoned by a timer mechanism, and seven seconds later the drogue chute was deployed. At 10,000 feet the large cargo parachute was deployed, letting the capsule down for a soft landing in the Atlantic. The monkey, called Miss Sam, to denote the School of Aviation Medicine, was picked up by a helicopter 10 minutes later and was back in the hands of her keepers just 30 minutes after launch.



LITTLE MISS Sam is placed in environment container prior to insertion in test capsule. The container was developed at the USAF School of Aviation Medicine.

The booster produced a little more thrust than expected. NASA officials before launch had predicted that the top of the trajectory would be only 38,000 ft. rather than the 48,900 ft. actually achieved.

The AF School of Aviation project strapped a 6-lb., 3-year-old female rhesus monkey into the capsule within a 100-lb. container. The monkey used a form-fitting couch similar to the type that will be used by the *Mercury* astronauts.

• **Weaker sex?**—Tests taken immediately after recovery indicated that the monkey had survived the jolting ride in good shape, and—for what its worth—in better shape than a male monkey, Mr. Sam, had been after his trip in *Little Joe III*.

During flight, Miss Sam had been trained to test her stresses under rocket flight by pulling a lever 100 times a minute every time a red light flashed over her head. A camera also recorded her reactions during flight. There was no immediate indication whether the lever-pulling stunt was a success.

The animal was immediately flown back to the School of Aviation Medicine's laboratories at Randolph Field, Tex., for further study.

Evolution—After two more *Little Joe* flights—the last with the McDonnell *Mercury* capsule on top—Project *Mercury* will go into high gear this spring with *Redstone*-launched flights 100 miles up and 100 miles down the Atlantic Missile range. Some of these flights will contain animals, and some are scheduled to contain the Project *Mercury* astronauts themselves.

Estimates as to when actual manned orbital flight will take place range from late 1961 to early 1963.

Demand for Missile Forgings Grows

Higher strength-weight ratio requirements spur need for applying blacksmith's art to exotic and common metals; Ladish, Wyman-Gordon lead field

by Jay Holmes

Forging, a process that originated before the dawn of recorded history, is in increasing demand for forming parts of the most advanced missiles and space vehicles.

Forging gives a metal shape and adds to the strength of soft portions of a casting. Rocket designers are turning to forging in increased amounts to meet the demands for ever higher strength-weight ratios.

Despite the antiquity of the process, many problems are new. Much is known about forging iron, standard steels, copper, aluminum and other common metals. But the missile and space vehicle demands application of the blacksmith's technique to the new high-strength steels, beryllium, titanium, magnesium and the refractory metals. Months or years of R&D work may be necessary before any one of these can be successfully forged.

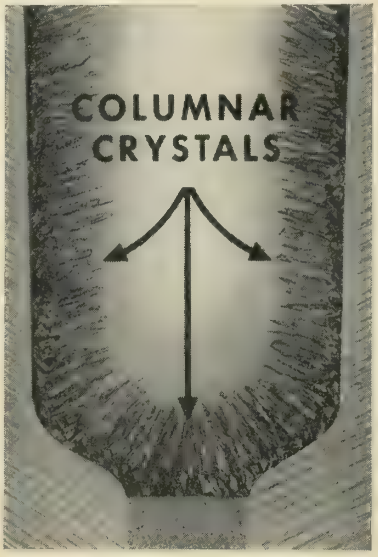
• **Two leaders**—In the United States, hundreds of companies, big and small, are in the forging business. But very few have large enough equipment or are able to work to the exacting tolerances set by the missile, nuclear and aircraft industries. Two concerns, the Wyman-Gordon Co. of Worcester, Mass., and the Ladish Co. of Cudahy, Wis., do the bulk of the missile forgings. Each is recognized industry leader in one of two competing forge methods. Ladish specializes in hammer forging—Wyman-Gordon in press forging.

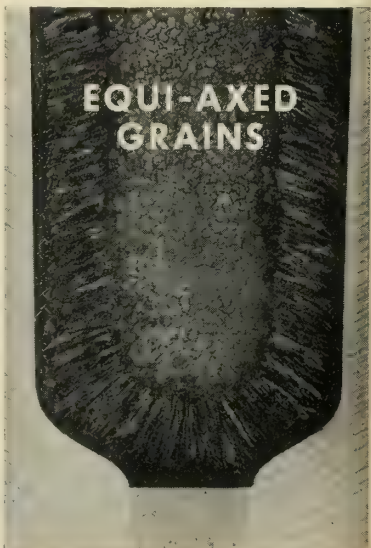
Other industry leaders supplying missile forgings include Baldwin-Lima-Hamilton Co., Midvale-Heppenstale Co., Canton Drop Forging Co., Taylor Forge Co., Harvey Aluminum, Aluminum Co. of America, Kropp Forge Co., the Hufford Corp. and Arturus Manufacturing Division of Airite Products.

Why forge at all? The fundamental reason lies in the nature of the casting process. As any molten metal cools, the metal near the walls crystallizes first, forming a thin, tough crust. As the hot metal gives its heat to the mold, the liquid inside this layer solidifies more slowly. Crystals in this zone form at right angles to the surface and are fairly strong.

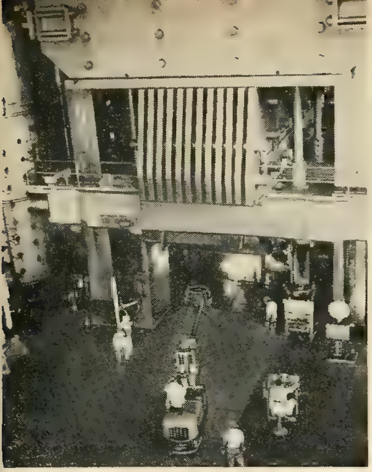
But at the middle of the ingot, crystallization takes place almost instantaneously, producing a coarse, equi-axed grain that lacks strength. At the corners of the mold, the longitudinal crystals may meet at a sharply defined line of cleavage. Such a line obviously is weaker.

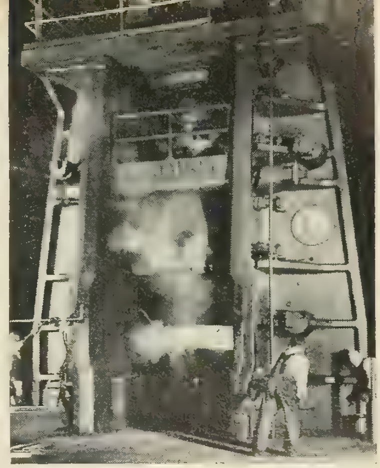
After the metal solidifies, but while it is still plastic, the constituents may separate into small bodies of segregates with non-metallics and impurities distributed in varying degrees. The uneven





WHY FORGE? These Ladish Co. photos show how any casting forms from molten metal. First, strong chill crystals form at surface. Then, columnar crystals solidify slowly and lend strength. At center, weak, equi-axed grain forms quickly. Another





LEFT — HYDRAULICALLY-OPERATED press at Wyman-Gordon Co. is five stories high, runs 10 stories underground.

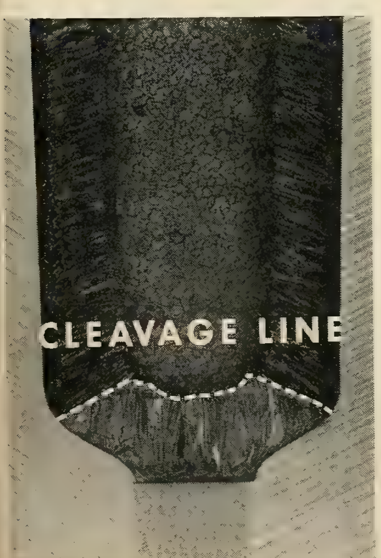
RIGHT—WORLD'S LARGEST closed impression die forging hammer at Ladish Co. can exert a 100,000-ton force.

distribution introduces further weaknesses in the metal.

The only way these characteristic casting properties can be modified and improved is by working the metal. By hot-working, grain structure is broken up and refined. Any cavities that exist are compacted and welded together. Segregates are broken up and the grain fibers are aligned.

The forging industry says forging makes possible a controlled improvement of metallurgical characteristics. Casting or machining by themselves are limited in the amount of grain structure control possible.

• **Missiles' special need**—Many industries, of course, demand the extremely high metal strength that can be produced by high-quality forgings. Automobile crankshafts must have tremendous strength at the bend points. Aircraft landing gears require great impact resistance. Jet engine parts have stringent strength requirements for very unusual shapes.



area subject to fracture under stress, is cleavage line from corners.

But the forging industry contends missiles and space vehicles have an even more urgent need of high metal quality. For a missile must not only have extremely high strength, its weight must be kept to a minimum. Unlike a bridge builder, a missile designer is not always free to add reinforcement to possible weak area. The extra metal may add too much weight.

To do the job on large pieces of metal, huge machines have been installed in some plants. In World War II, The Air Force built a 50,000-ton closed-impression hydraulic press at the Wyman-Gordon Worcester plant. The Aluminum Co. of America has built a similar sized press, used mainly for aluminum, at Pittsburgh.

The largest closed-impression die forging hammer in the world was put in operation last year by the Ladish Co. at its plant in Cudahy, Wis. The counterblow hammer, rated at 125,000 meter-kilograms, has a 96" vertical stroke and exerts a force of more than 100,000 tons at the moment of impact.

• **Place for both**—There is some disagreement in the industry about whether the hammer or press method is better. However, partisans of both methods feel there is a place for both press-forging and hammer forging.

Wyman-Gordon spokesmen say that, given equal technical ability and equal physical capability, a forging can be accomplished equally well on a hammer or a press. However, they say that hammers in existence do not have the physical capability of doing the jobs that can be done by huge presses on metal pieces larger than 14" in diameter. Wyman-Gordon says it uses hammers for some small jobs for economy.

Ladish Co. engineers maintain that the limitations of large hammers have been removed by introduction of the two-way counterblow hammer. The counterblow design, they say, permits directing all the energy to the forging blank and eliminates the effect of shock on neighboring areas.

The Ladish 125,000 meter-kilogram forging hammer extends the inherent advantages of hammer forging to sizes in excess of 20,000 lbs. in carbon, alloy and stainless steel, in sizes up to 200" long and 70" in diameter, Ladish says.

Wyman-Gordon says magnesium, beryllium, super-nickel base alloys, some refractory metal alloys and all-beta titanium alloys press-forge better than they hammer-forge.

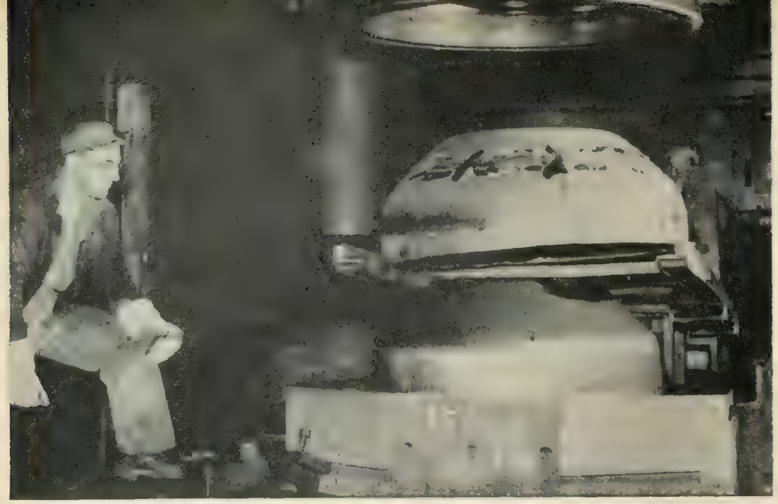
• **Throughout the missile**—Forgings are used from one end of the missile to the other. Wyman-Gordon reports it has forged copper heat shields 65" in diameter and weighing 2000 lbs. for the *Atlas;* several large hollow beryllium objects with wall thickness about 1" and weighing 160 lbs. for a classified customer; magnesium and aluminum rings for re-entry vehicles; aluminum and magnesium pieces for *Hound Dog;* solid propellant motor casing cylinders, forward domes, aft heads and closures of steel and titanium; and outer nozzles of steel and titanium; molybdenum throat inserts and liners.

Tantalum and tantalum alloy forgings are being developed for use as throat inserts and liners. Tungsten also is in development but in a very early stage. In the liquid rocket systems, Wyman-Gordon is producing titanium and stainless steel forgings for helium pressure bottles. Turbine wheels for turbopumps on the big Rocketdyne and Aerojet engines are forged of Rene 41, a nickel-based alloy.

Ladish reports it has forged forward domes, aft closures, bulkheads, body adapters and nozzle throat inserts. Parts have been supplied for *Minuteman, Titan, Thor, Polaris, Atlas, Sparrow, Bomarc, Hawk, Nike-Ajax, Hercules* and *Zeus, Talos, Terrier, Jupiter, Lacrosse, Little John, Matador* and *Honest John.*

The Wisconsin company says it has experience in working such "exotic" metals as titanium, tungsten, tantalum, beryllium, niobium (columbium), molybdenum, magnesium and its patented D6, a low-alloy die steel that has been used with great success in missile applications.

Wyman-Gordon has forged nylon



TITANIUM MOTOR CASING CLOSURE forged at the Wyman-Gordon—U.S.A.F. plant in North Grafton, Mass., weighs 441 lbs. and has 41.16" O. D.

Some Applications of Press-Forging

Metal	*Forging Temp. (°F)*	*Typical Applications*
Aluminum: 2014, 7075, 7079, *2025, X2219	700-850	Frame members, structural parts, bulkheads, closures. *Warm compressors and inducers.
Magnesium: ZK60, AZ80, HM21, HK31	600-800	Fittings, control linkages, wheel rims, electronic assembly frames and covers, frames and bulkheads.
Low Alloy Steels: AISI 4140, AISI 4340, AMS 6418, AMS 6304	2100-2300	Outer nozzles, fittings, frame parts, connecting rods and crankshafts. Shaft and gear assemblies.
Hot-work Die Steels: AISI 9310, Nitralloy	2000-2250	Motor closures, fittings, frame parts for higher temperature applications than the low alloy steels.
Stainless Steels: 304, 321, 325, 329, 347	2000-2250	Engine parts, valves, nuclear reactors.
17—7PH, AM 355, 17—4PH		Low temperature pressure bottles, frame parts requiring strength and heat and corrosion resistance.
Iron Base High Temperature Alloys: AMS 5735, A-286, Inco 901, M-308, V-57, W-545	1900-2100	Turbo-pump components for liquid rocket engines, bolts, rings.
Nickel Base High Temperature Alloys: Waspaloy, Nimonic 80A, René 41, Astroloy, Inconel X	1900-2100	Turbo-pump components for liquid rocket engines, same as iron base high temperature alloys except these alloys have higher operating temperature ranges.
Titanium: 6Al-4V, B120VCA	1350-1950	Motor closures, pressure bottles, frame parts.
Molybdenum and Molybdenum-Tungsten	2100-2600	Rocket nozzle throats and liners and rings.
Tantalum & Tantalum-Tungsten Alloys	2100-2300	Rocket nozzle throats and liners and rings, nuclear reactors, re-entry vehicle skin and structures.
Tungsten	Above 2500	Re-entry vehicle skin and structures.
Niobium	2100-2350	Nuclear reactors, re-entry vehicle skin and structures.
Beryllium	1600-2000	Re-entry heat shields, payload structures, guidance components.
Copper	1400-1750	Re-entry heat shield.
Hafnium	1800-2000	Nuclear reactor control rods.

on an experimental basis and is interested in forging Teflon. The Massachusetts company believes there is a field for forging plastics.

• **Reducing welds**—The forging industry is convinced that some of the trouble with solid-fuel rocket cases in the early days was caused by an excessive amount of welding, particularly on the longitudinal seam. Girth welds can be troublesome too but the geometry of a cylindrical pressure vessel puts only half as much stress on a girth seam as on a longitudinal seam.

Welders maintain that by good technique and reinforcement they can eliminate weld weaknesses. But the forging industry contends it is impossible to eliminate the possibility of a mismatch in metal grain and the associated stress concentrations. Spokesmen say a case with the minimum number of welds has the highest reliability and the maximum burst strength.

• **Exploring new fields**—The "exotic" metals are receiving much attention by the forging industry. Both major companies are forging beryllium guidance components. The metal is chosen not only because of its density but also for its high modulus of elasticity. Furthermore, its coefficient of thermal expansion is close to that of steel.

The refractory metals also are receiving much attention. Besides Ladish and Wyman-Gordon, Cameron Iron Works reports success in forging unalloyed cast molybdenum, 90% tantalum, 10% tungsten, and zircaloy-2, a zirconium-base alloy used for nuclear applications. Super-Temp Engineering & Manufacturing of Los Angeles says it has developed techniques for forging large diameter pure tungsten and molybdenum-tungsten billets.

Wyman-Gordon metallurgists feel there is a good future also for the all-beta titanium alloy B120 VCA (vanadium, chromium and aluminum added). They say it can be developed with a minimum 180,000 psi yield strength at 4% to 6% elongation, the equivalent of steel at more than 280,000 psi.

Ladish is betting on its D6 steel, which was developed originally for use as a forging die and kept secret for almost 15 years. Other popular low-alloy forging steels are 300M (also known at Tricent), H-11 (Vascojet 1000) and U. S. Steel's X-200.

Regardless of the missile market, forging industry executives foresee substantial business gains this year. A year-end survey by the Drop Forging Assn. revealed that several major forging plants report the largest backlog of orders in many years. Some executives expect gains of as much as 25% over last year.

Reds Charge:

Project *Mercury* Is 'Sheer Sensationalism'

Soviet space experts leveled a severe blast at Project *Mercury* on grounds that the United States does not have solutions to many problems involved in orbiting and recovering a man from space.

Prof. Y. A. Pobedonostsev, in a discussion by Soviet space scientists and legal experts reported in the Russian "International Affairs" magazine, labels U.S. aspirations as "sheer sensationalism." First, he argues, the U.S. is far from able to provide adequate protection for the human occupant of a capsule which would heat up to 3000° or higher during re-entry.

In addition, he contends, no parachute has yet been constructed by the United States that could provide a safe descent from a high altitude. Cloth would char or burn if used at an altitude of 60 miles above the earth. This will continue to be a major problem, he states, since even if the capsule has an initial speed of zero, its orbit velocity would probably be about 1.6 miles per second, making most materials unusable.

At the same meeting, a Soviet legal expert accused the United States of planning to use celestial bodies as testing grounds for nuclear weapons and eventually as bases for dropping nuclear bombs on earth.

Dr. G. P. Zadorozhny labeled the U.S. "Man in Space" program as a means to acquire ownership of the moon for military bases. He accused the U.S. of changing its attitude toward the legal question only when it looked as though America might not be first on the moon.

Another Soviet legal specialist, G. P. Zhukov, claimed that the U.S. was already making illegal attempts to use space for military purposes. He urged that agreement be reached on banning all military activity in space, and making international agreements limiting the sovereignty of each nation to a "relatively low limit" above the earth.

Computer Conference

The Seventh Annual Symposium on Computers and Data Processing has been set here for July 28 and 29. Sponsored by University of Denver Research Institute, the symposium will present papers in components and devices, logic design, and philosophy of computer design. Deadline for uninvited papers is April 1.

Process Makes Unusually Flat Ti Alloy Sheets

Large titanium alloy sheets, heat treated to strengths in excess of 190,000 psi, have been made through a new process at Republic Steel Corp. of Cleveland.

The alloy, RS-140 (5.0% Al; 1.25% Fe; 2.75% Cr), is available in gages as light as 0.010 in. and in sheet sizes up to 48 x 120 in. in the fully heat-treated condition.

An unusual degree of flatness—2.3-2.5%—has been achieved, Republic reports. Best flatness obtained to date in other methods ranged between 8 and 10%.

The firm uses a five-zone, electrically heated, continuous roller hearth furnace which provides a high degree of heat uniformity—each zone maintaining a ±10°F variation. Coated sheets of titanium alloy are heated for short periods between 1400 and 1700°F depending upon the alloy grade. This is followed by water quenching in a continuous roller unit. The coating prevents contamination by atmospheric and other gases and can be cleaned without molten caustic.

After treatment, the sheets are soft and may be either hot- or cold-formed, then aged for several hours around 900°F to high strength levels. Republic metallurgists attribute the flatness to the electric platen aging methods employed.

NASA Backs Study of Metal Pumping Cavitation

The problem of erosion and cavitation in the pumping of liquid metals is being investigated at the University of Michigan's Research Institute, Ann Arbor, Mich., under a $93,710 grant from the National Aeronautics and Space Administration.

Directed by Dr. Frederick G. Hammitt of the Mechanical and Nuclear Engineering Department, the investigation will provide insight into the behavior of liquid metals as heat removal media and working fluids in nuclear powerplants.

Hammitt explained that cavitation is the result of pressure depression near a pump's vanes, because of their movement through a liquid. These "bubbles" move into a pump's high-pressure region and collapse in a violent reaction which can break down the strongest material.

Cryogenic Gyro Seen from GE Project

Superconductive coil which creates a magnetic field and can remain constant indefinitely should provide gyro with more accuracy and higher reliability

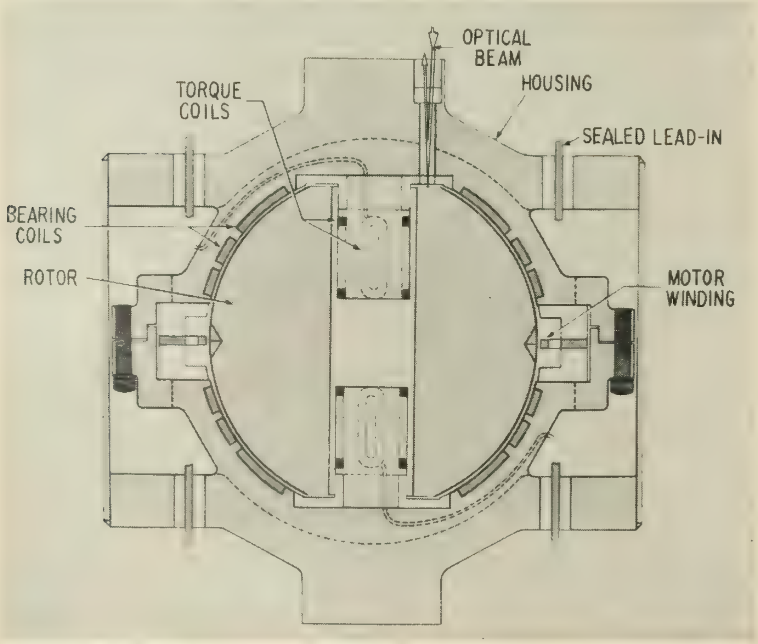
A cryogenic gyroscope that will be many times more accurate, and of higher reliability, than any existing gyro is expected to result from "Project Spin" at General Electric's General Engineering Laboratory in Schenectady, N.Y.

The key is in superconductivity, a phenomena first observed by Onnes in 1911, when he found that the electrical resistance of mercury approached zero at —452.3°F. Essentially this means that a current in such a conductor will flow forever unless interrupted.

Resistivity can be introduced by raising the temperature above a critical point characteristic of the particular metal, or if the material is placed in a significantly strong magnetic field at a lower temperature.

Since a current can be effectively trapped in a superconductive coil, a magnetic field can be created which will remain constant indefinitely. The current will remain constant if the dimensions of the coil do not change. This is the heart of GE's superconductive gyro.

One version of the basic concept, operated at liquid helium temperatures, was designed around a cylindrical shell rotor. The rotor operated, magnetically suspended in space, for many hours at a very high speed, in a high vacuum. The only known loss was due to imperfections in the vacuum.



CRYOGENIC gyroscope under development at GE features a rotor designed for rotation at high speed inside a vacuum.

Many experiments have demonstrated the feasibility of suspending and rotating a metal body within a vacuum for long periods, the only means of support being a frictionless magnetic field. The ultimate coast-down time of such an object has not yet been determined, but James F. Young, the Laboratory's General Manager, said that it should spin freely for many months and possibly years.

These feasibility studies led to a development contract with the Army Ballistic Missile Agency in March 1959, identified as "Project Spin."

Principles of the device are being used in laboratory work on the gyroscope under the "Spin" project, sponsored by GE's Ordnance Department.

The anticipated accuracy of the gyro is a result of the elimination of the principal sources of unpredictable gyro errors-friction and electrical losses. Its reliability is based on the dimensional stability induced by cryogenic temperatures.

Utilizing liquid helium, a small sphere is currently being prepared for advanced tests at rotation speeds up to 20,000 RPM, within a high vacuum.

• **Other uses**—Company spokesmen point out that the full impact of cryogenic research in this area has many increasingly beneficial aspects in varied applications.

A superconductive magnetic lens applied to an electronic microscope would permit a tremendous increase in resolving power. The possibility of actually "seeing" atoms in this manner is real.

A signal source could be fed into a lossless, superconductive control winding. The flux from this winding

THIS GOLFBALL-SIZED sphere is suspended solely by an invisible magnetic field near temperatures of absolute zero.

could be chopped by a rotating superconductive disc consisting of segments which act as magnetic insulation. In a second winding, an AC voltage and output power would be produced—thus an AC to DC amplifier having no zero drift and no noise.

The late Dudley A. Buck developed the cryotron—a device which employs two superconductors of different materials. When current is applied to one, it sets up a magnetic field which induces resistivity in the other—thus acting as a two position switch. GE scientists say that all basic types of computer circuits could be built from combinations of these cryotrons—making small, highly accurate computers possible.

In oscillators, resonant cavities with very little damping are possible with superconductors because of their very small surface resistance at high frequencies. It would seem possible that frequency standard oscillators using such cavities could be made with accuracies approaching those of atomic clocks. The main drawback here seems to be that increasing the cavity frequency decreases the effectiveness of the superconductor.

• **Only beginning**—GE scientists say that the entire field of cryogenics is in its infancy. Much has to be done in both research and development. Most of the 23 or so materials found to be superconductive have to be cooled to about the temperature of liquid helium—creating a definite problem of temperature maintenance. Indicative of this is that if a substance can be made a superconductor at the temperature of liquid hydrogen or liquid nitrogen, practical usage of superconductors in special transformers, generator stator windings, large particle accelerator coils and large energy storage and discharge systems would be economically feasible.

Biomedical Tests Made in Race Car

First test of a Northrop biomedical instrumentation system designed to telemeter physical and emotional reactions of spacemen to earth was made at Riverside, Calif., in a 170-mph racing car.

Instrumentation included a "bio-pack" to pick up and amplify body reactions and Ampex Corp. airborne flight test recorders. Key elements in the bio-pack are miniature Litton Industries bio-amplifiers.

Two-man crew of the Lotus XV racing car was connected by electrodes to instruments recording pulse, breathing, heart and brain reactions to stress. Also recorded was galvanic skin resistance to indicate emotional changes.

Accelerometers measured the forward and lateral acceleration of the car and an electric eye recorded revolutions of the driveshaft to provide exact speed readings.

This information was coordinated with the biomedical readings to provide Norair engineers with crew reactions at any given speed or in emergencies such as a skid.

Tape-recorded information recorded in the track runs was processed in Norair's computing and data reduction facilities at Hawthorne.

The system is designed to give ground-based flight surgeons instant and continuous readings of the physical and emotional condition of crews during space flights.

This was its first test on a human under prolonged stress conditions. The racing car was piloted by Jay Chamberlain, 1957 winner of the 1100 cc. class at Le Mans.

Lectures Series Set for Missile/Space Support

A series of 18 lectures on support systems for missile and space vehicles has been scheduled statewide in the University of California extension program at Los Angeles.

The lectures will deal with management concepts, operational procedures, subsystem development, logistical considerations and other aspects of the field.

Speakers will be drawn largely from Space Technology Laboratories and RAND Corp.

First of the lectures is scheduled for Feb. 8 in San Diego, Feb. 9 in Los Angeles, Feb. 10 in Riverside, Feb. 11 in Lancaster and Feb. 13 in Palo Alto.

Small Firm Wins Ion Engine Contract

Electro-Optical beats out big companies and will make first ion engine for space; NASA engine will be more sophisticated but longer in arriving

The first ion engine to be used in space will be a product of a 200-employe company in Pasadena, Calif. The Air Force has awarded a contract for "quick and dirty" construction of an ion device to Electro-Optical Systems Inc. of Pasadena.

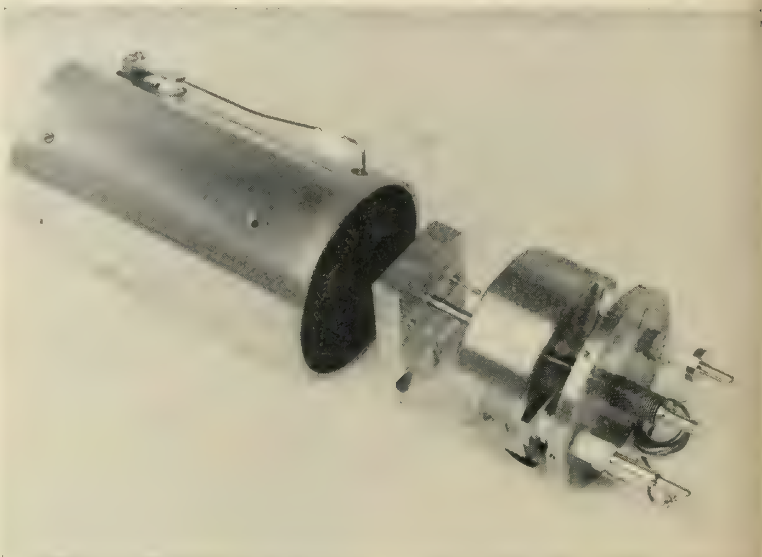
EOS beat out such industry giants as Rocketdyne, Aerojet-General, General Electric, Lockheed, Avco and United Research, among others, in the competition.

While no timetable for the Air Force program using an ion engine was announced, it has been estimated that a useful ion device could be developed and placed into orbit, assuming full financial support, in from 1½ to 3 years. This does not take into account the development time required for a flyable nuclear reactor that would provide sufficient power for such a device.

In addition to the Air Force program, being handled by Air Research and Development Command, the National Aeronautics and Space Administration also is developing an ion engine. The NASA engine will be more sophisticated, but will take longer to produce.

• **NASA involved**—Both NASA and ARDC's Wright Air Development Command have produced workable small ion devices in-house. The NASA machine was built at Lewis Research Center in Cleveland. The ARDC device was built at WADC Command headquarters in Dayton. In addition, Army Ballistic Missile Agency, soon to be transferred to NASA, has been doing continuing research and has let small research contracts to Electro-Optical, High-Voltage Engineering Corp. and General Electric.

Within the next week or two, NASA plans to circulate a contract calling for development of components and eventual construction of a device that draws 30 kilowatts of power. Assuming specific impulse of 5000 sec. and efficiency of 50% (which experts in the field believe to be reasonable assumptions), this would generate about 0.1 lb. of thrust. However, the first device under the NASA contract will not be flyable. It will be a laboratory device designed to demonstrate thrust. Another NASA contract will call for development of a small one-kilowatt device.



EXPLODED VIEW of .002-lb-thrust ion propulsion engine under study at Electro-Optical. Left to right: ionizer surface, cesium reservoir and plugs connecting it to advance power supply. Ribbon along side carries current to ionizer.

The design of the proposed Air Force engine will be based on a prototype engine that has been under study at Electro-Optical. This engine, with .002 lbs. thrust, is 7½" long, 4" in diameter and about 2 lbs. in weight, exclusive of power supply. The Air Force version will undoubtedly be an advanced model of this device with higher thrust. Reports in industry have put the Air Force thrust requirement at 0.1 lb.

• **Small market, big potential**—In addition to the ion devices, NASA is receiving bids shortly on two small plasma propulsion devices. As in the case of the ion devices, neither NASA nor those bidding are willing to give any indication of the amount of money involved. However, an informed guess would be that the figure in each case is in thousands rather than millions of dollars.

One indication of the size of the market is the NASA budget for electrical propulsion. For the 1960-61 fiscal year, NASA is asking about $6 million, roughly twice the amount it is spending in the current fiscal year. This includes NASA's in-house efforts, of course. No such breakdown of Air Force funds is available, but it is believed unlikely that AF is spending any more than NASA in this area.

Despite the relatively small size of the market, industry is very interested. The reason is its great potential. The devices are just coming from the research phase into R&D, but eventually large devices will be built for satellite

orbit correction and spaceship propulsion. It seems a good bet that such lucrative future contracts will go to companies that are now pioneering in the field.

Industry observers expect the six companies mentioned earlier, as well as Electro-Optical, to bid on the upcoming NASA contract. Others interested in ion or plasma propulsion include Tapco Group of Thompson-Ramo-Wooldridge, Goodrich, High Voltage Engineering, Borg-Warner, Republic Aviation and Giannini Plasmadyne.

• **Cesium-powered**—An ion engine uses the rare metal cesium as a propellant. A member of the sodium-potassium family, cesium has the lowest ionization potential of any element with the possible exception of the radioactive element francium (No. 87), which is so rare that its ionization potential is not listed in standard reference works.

The cesium is vaporized and brought into contact with tungsten, where each atom loses its valence electron. The positive ions are then attracted toward a negative electrode in the rear. Many ions sweep past these electrodes and provide propulsion.

In a device operating at 30 kilowatts, about .01 lb. of cesium per hour would be consumed. The metal costs between $600 and $1000 per lb. However, a large deposit of pollucite, an aluminum-cesium silicate, is being developed in Southern Rhodesia and quantity production is likely to bring the price down.

Plasma production, on the other hand, operates on a principle of electromagnetically accelerating a highly ionized but electrically neutral mixture of particles to obtain thrust. Assuming a specific impulse of 1000 to 1500 sec., the plasma device thrust would be about three to five times higher than that of an ion engine, given equivalent power sources and efficiency.

Electro-Optical's two-millipound prototype ion engine uses a lightweight steel casing with a tungsten mesh ionizer surface and graphite accelerating electrodes. However, it is not limited to these materials. Later models may use beryllium or tantalum accelerating electrodes. These would not be as seriously affected by sputtering—the erosion of a surface because of ion impact.

• **Problems remain**—A number of major problems remain to be solved, including the neutralization of the positively-charged ion beam, and the control or elimination of sputtering. Neutralization must be accomplished, otherwise there would be no flow of ions from the accelerating chamber into space.

The efficiency of the two-millipound prototype is 72½%. An efficiency of almost 100% is possible, with the perfection of techniques.

The research embodied in the development of an ion engine at Electro-Optical has recently been aimed at component development and engineering. The company feels a number of problems must be solved "before sound engineering decisions can be made."

To provide cesium vapors to the surface of the ionizer, vapor pressure has been utilized, providing a stable, reliable source. To provide a valve and metering capability, however, a new method is being developed. This system would use a cesium glass, through which the cesium vapor would be electrolytically diffused, such as with a membrane, thereby giving an accurate and controllable vapor flow.

EOS plans to use the new method for evaluation of the efficiency of various ionizer surfaces and configurations, i.e., porous tungsten, staggered ribbon, or woven tungsten.

In designing accelerating systems, EOS used two types: parallel plate and the Pierce system. The former was utilized mainly in the study of ionizer characteristics, and the latter to evaluate the staggered ribbon source, and in neutralization studies. The Pierce system of linear acceleration was modified to include two focusing electrodes which would minimize ion interception by the accelerating electrodes, thus reducing sputtering.

The neutralization problem, one of the major stumbling blocks in the ion engine development, was attacked with two different methods: Injection of electrons into the ion beam; and that in which atoms are sent across the beam to neutralize it by charge exchange. The latter is not considered feasible for space flight, because of the undesirable effect on the accelerators, although results of the electron injection are viewed with cautious optimism.

• **A long life**—Thrust ratings for ion engines and similar thrust devices appear almost negligible when compared with chemical rockets, but their duration of operation is the key to many applications.

Correction of satellite orientation and orbit are the most likely uses in the immediate future, and sustained-thrust applications for pushing large payloads about space is a later probability. In the first application, it has been estimated that ion systems are superior to chemical or compressed gas sources if the total velocity increment to be generated over the lifetime of the satellite is 100 meters per sec. or more. If less than this is required, a compressed gas or chemical source is lighter.

Accelerometer Claimed to Be Smallest

A subminiature self-generating accelerometer, less than 0.1" in height, 0.5" in diameter, and weighing ¾ gram, has been developed by the instrumentation Division of Gulton Industries, Inc. The unit is believed to be the thinnest and lightest accelerometer commercially available today.

It is particularly suited for use in wind tunnel testing of simulated aircraft where weight is an important factor in selecting an instrument to determine wing flutter, tab buzz or control system response. Featherweight construction and cement-down mounting also allows the accelerometer to be used on miniature electronic components without materially changing the characteristics of the component involved.

The minute profile of the accelerometer permits it to be inserted between the skin and strut of a plane or missile. In addition, it can be built into many types of electronic gear, as a permanent installation. This permits periodic checks of vibratory conditions, as well as making it unnecessary to disassemble the equipment to remove the accelerometer after it has served its purpose. The unique isolated bender design provides low acoustic response and low transverse sensitivity as well as eliminating torque sensitivity.

Housed in aluminum, the Model A-31109 accelerometer has an acceleration range of 0.5 to 500 g and has a useful frequency range of 3 to 4000 cps and a sensitivity of 2 mv/g minimum. Its operating range is —65°F to +250°F. Resonant frequency is 12 KC minimum.

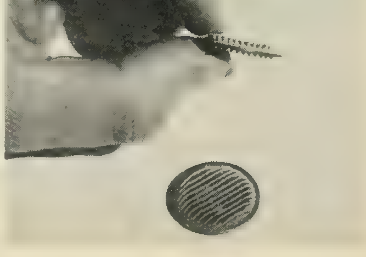
Each accelerometer is equipped with a permanently attached four foot length of Glennite Blackline Low Noise Cable fitted with a C5P connector. Calibration data and mating connector is supplied as well.

The new Gulton Accelerometer is also available in another model, designated the A-3108, which weighs two grams and is enclosed in a brass housing. It features greater sensitivity and broader frequency response than the lighter model A-3109.

Circle No. 225 on Subscriber Service Card.

Stainless Steel Filter Cleans Exhaust Bleed Gas

A special disc type stainless steel wire cloth filter for use in the *Sidewinder* missile is announced by Bendix Filter



Division of Bendix Aviation Corp.

The filter was designed to clean exhaust bleed gases from the rocket motor to actuate control surfaces. Filtration allows smooth operation of the control surface actuating system and is important in attaining requiring flight accuracy.

The filter is rated for continuous operation up to 1200°F. Bendix rates it at 5 microns, and says it has a very low pressure drop, long storage life and simplified installation.

A soft copper ring, crimped to the edges of the pleated wire cloth disc, provides rigidity and a smooth sealing surface which eliminates the need for any gaskets or seals.

Circle No. 226 on Subscriber Service Card.

Tube Removal Without Circuit Shift Possible

Instruments for Industry, Inc., has designed a tube socket for the General Electric GL6299 UHF planar triode that enables the designer to realize practical UHF lumped constant circuitry with assurance of bandpass stability as tubes are changed.

Designated as XV-100/6299, the socket permits tube removal and replacement with absolute seating every time. Precise engineering and design techniques permit the miniaturized tube socket to be used to 1000 mc or higher with no resonances over the band.

Problems of poor grounding and high contact inductance which seriously limit upper operating frequency are said to be eliminated, as well as the problem of varying circuit values resulting from shift of contracts, circuit parts and poor seating.

Since the 6299 tube socket is primarily intended for grounded grid service, it provides a minimum of inductance for the grid return path to ground. The ground plane provides isolation between input and output for amplifier stability.

Allied applications for the tube socket are for broadband circuitry and receivers, amplifiers, mixers—or where both frequency stability and low noise factors are important.

Circle No. 227 on Subscriber Service Card.

Dynameter Measures to 200,000 lbs. of Force

Two new capacities, 150,000 and 200,000 lbs. have been added to W. C. Dillon & Co. Inc.'s line of direct-

reading, traction-type Dynamometers (portable force-measuring instruments). Fifteen capacities from 0-500 lbs. up to 0-200,000 lbs. are now available.

Both new units have a net weight of 23 lbs., independent of shackles, pins and shunt bar, and have highly visible 10" diameter dials. All parts of the Dynamometers are made to withstand rough usage. The case is heavy metal—dial is 22-gauge brass, protected by a ¼" thick plastic crystal. These instruments are designed to withstand roughest weather for field work, as well as the strain of heavy industrial applications.

All Dillon Dynamometers incorporate the following features: resetable red maximum hand which "remembers" point of peak load; removable clevises of drop forged alloy steel; ultrasensitive mechanism produces a full-scale reading with only .040" deflection of the special alloy steel beam regardless of capacity; fatigue-tested beam retains its resiliency indefinitely without creep or hysteresis; overload protection built into the beam sustains appreciable surges without damage to calibration; individually calibrated to an accuracy of 2% plus or minus full-range. Measures torque, traction, tension, compression or weight.

Circle No. 228 on Subscriber Service Card.

Alkaline Method Patented For Derusting of Steel

The Endox process, a patented, alkaline method for derusting and descaling of steel and activating it for plating, has been annuonced by Enthone, Inc., subsidiary of American Smelting & Refining Co. The process removes rust, scale, carbon smut, oxides and light soil from iron and steel alloys by electrolytic treatment in an alkaline solution at room temperature.

Acid pickling with its accompanying attack of the work and surrounding equipment and its production of carbon smut on the steel surface is eliminated. Acid dips in plating lines are also eliminated due to the deoxidizing and activating ability of the Endox process. Complete preparation of steel for plating in one simple step is possible with this alkaline process.

Either of two new products, Endox 209 or Endox 214, can be used to make up the processing solution. Both are completely prepared, powdered materials which need only be dissolved in cold water and concentrations of from 1 to 3 lbs/gal. to make up the bath. No other salts are required. Endox 209 is superior for scale removal while Endox 214 is preferable where heavy rust is present. Electrolytic treatment with either direct or periodic-reverse current can be employed.

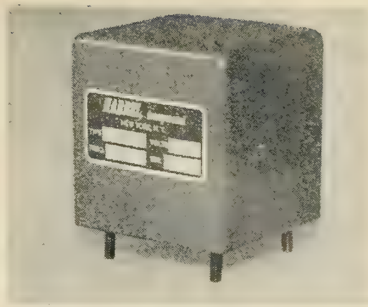
The Endox bath can be maintained indefinitely by periodic analysis and replenishment and by occasional removal of precipitated sludge. Since the bath is seldom dumped, it is very economical to operate.

Circle No. 229 on Subscriber Service Card.

Gyro Temperatures Kept Within Close Tolerances

Extremely close temperature control of high precision floated gyroscopes and accelerometers is achieved by the new TC200 series of proportional temperature controllers announced by Harrel, Inc. Using semiconductor switching techniques, the new unit achieves a power output of 100 watts or more at an efficiency of better than 94% overall.

The proportional nature of the control eliminates the dead zone characteristic of relay type controllers and allows extremely close control of temperature. At the same time, the response time of the controller is a fraction of a second, allowing the gyro to adjust rapidly to changes in ambient conditions. This rapid response also eliminated destructive overshoots in temperature during



initial warm-up of the gyro.

The controller is completely solid-state and is furnished in a hermetically sealed enclosure with 7 pin terminal header, to meet all applicable MIL specifications. Forms can be furnished in special enclosures for production missile or airborne systems.

Circle No. 230 on Subscriber Service Card.

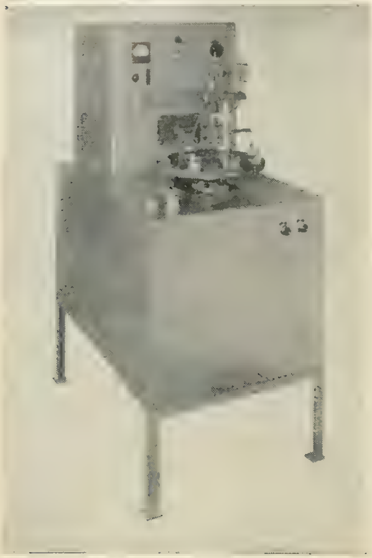
Miniature Crystal Can Solderer Introduced

An automatic miniature crystal can solderer has been produced by Reeve Electronics, Inc.

The unit, consisting of an induction heating generator with special tooling, is said to eliminate time and expense

of soldering miniature crystal cans, and provides a decrease in rejects, due to heat-caused frequency changes.

The basic equipment consists of: an induction generator; a special variable speed, motor-driven, 16 station turntable on which the generator is mounted and connected; special spring-



loaded holding jigs into which the crystals are assembled and held; a special two-stage heating coil where soldering takes place; a special fluxing assembly which applies the proper amount of flux to the outside of the assembly after the first heating cycle; and operator controls and switching circuitry to synchronize the generator and turntable.

Circle No. 231 on Subscriber Service Card.

Alternative Installation Permitted by New Relays

A new development in printed circuit relays is announced by C. P. Clare & Co., manufacturers of relays and allied electronic components. It consists of an assembly which permits single or multiple installation of Clare mercury-wetted contact relays in the small space of a printed circuit board. It plugs into a console in the same manner as the logic circuit it serves.

The individual switch capsules and coils are affixed to the printed circuit board and sealed from dust, moisture and tampering by the application of "Skin-Pack," a tough vinyl coating.

Customers' printed circuit boards may be adapted to include either the standard Clare HG mercury-wetted contact relay, or the ultra-high-speed HGS, as well as other selected components.

Circle No. 232 on Subscriber Service Card

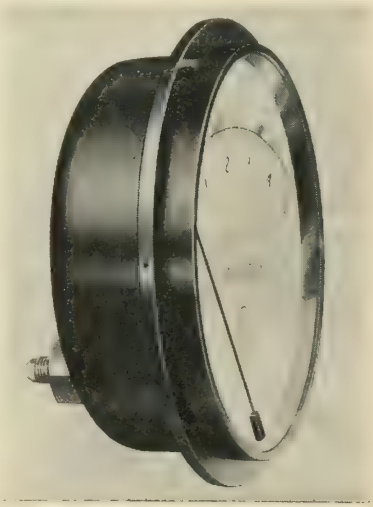
Pressure Gauge Designed For Use in Laboratory

A permanently accurate pressure gauge bearing the Bourdon-Helix trademark, specifically designed for laboratory use, is now being offered by Glassco Instrument Co.

The regular recalibration schedule, for years the bane of laboratory technicians, is no longer necessary. Manufacturer states this new Bourdon-Helix gauge will retain its accuracy permanently, with no maintenance or recalibration required throughout its life, even when exposed to extreme shock, vibration, and line pressure surges.

The new gauges are individually calibrated by dead weight tester to a guaranteed accuracy of ±¼ of 1%, including calibration and hysteresis variation throughout the entire scale. They are now available in pressure ranges from 0-100 to 0-10,000 psi, with a 6" dial and mirror reflection band behind the needle to eliminate parallax error.

The Bourdon-Helix pressure gauge has only one moving part, a helically wound bourdon tube connected direct-



ly to the pressure source. Internal pressures cause the tube to unwind sweeping the pointer, at the free end, across the dial face. One permanently efficient moving part replaces linkage and componentry which so often affect accuracy in conventional gauges.

Glassco Bourdon-Helix pressure gauges were originally custom designed to meet the most demanding requirements of the missile and spacecraft industry, such as in the *Talos* and *Nike-Hercules* missiles, and the Lockheed F-104 Starfighter. These same characteristics are now available for laboratory application with the new Glassco gauges.

Circle No. 233 on Subscriber Service Card.

Lightweight Cryogenic Couplings Available

Lightweight U.S. Army Ordnance cryogenic couplings are now available from Futurecraft Distribution Corp. The couplings are screw-type, a new style that permits quick, easy and safe connection of flex lines, tubing, and pipe. Futurecraft says the couplings have been proven in ground support equipment service on Army Ordnance projects and are pressure rated at 150 psi operating, 300 psi proof, and 450 psi minimum burst.

Low torque is all that is required to seal Futurecraft cryogenic couplings fluid-tight. They are available in sizes from 1" to 4", in ½" increments, right-hand or left-hand thread, and LOX cleaned and packaged. Installation tools are available.

Circle No. 234 on Subscriber Service Card.

Cleaner Restores Filters To 'Like New' Condition

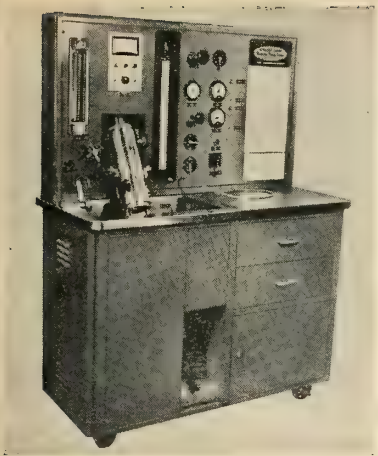
Used filter elements can now be cleaned to their original differential pressure and dirt-holding capacities by means of the Pall-Cavitron HIPS equipment. The unit is a joint development of the Pall Corp. and Cavitron Equipment Corp.

HIPS, HyperIntense Proximal Scanning, produces the maximum ultrasonic cleaning intensity that can be created in a liquid. It places a hyperintense field over a small portion of the surface of the filter at one time.

The filter element is rotated through this hyperintense proximal field until the entire surface of the element is cleaned. Particles are flushed away continuously as they are loosened. It takes less than 10 minutes to clean most filter elements to a "like-new" condition.

The basic ultrasonic generator and transducer used in the Pall-Cavitron HIPS system are modifications of the same "Cavitron" system in use for many years for the ultrasonic machining of metals and ceramics.

In addition, Pall-Cavitron HIPS contains bubble-point test equipment to test largest particle passed by the



cleaned filter, and equipment to measure pressure drop of a filter element. Both measurements are necessary to insure that the element is satisfactory for re-use.

Circle No. 235 on Subscriber Service Card.

Garrett Develops Two Valves for *Polaris*

Two new valves, designed for the *Polaris*-firing submarines, have been developed by the AiResearch Industrial Division of the Garrett Corp.

Both are integral parts of the launching system. One is a single stage pressure regulator that provides air at a constant, low pressure from a high pressure storage system. Part of this air is used to maintain proper pressure in the *Polaris* tubes prior to launch.

The second valve-type regulates the compressed air used to control the rapid movement of large volumes of ballast water to trim the boat when a missile is fired.

The valves have passed high impact and hydraulic shock tests and meet the stringent leakage requirements. They operate silently and occupy minimal space.

Circle No. 236 on Subscriber Service Card.

Data Processing System Called One of Fastest

The prototype of a new high-speed, fully transistorized data-processing system being built by Ferranti Ltd. is claimed to be one of the fastest and most powerful in the world.

Named Orion, it includes facilities for automatic sharing of the time of the central computer between several programs, so that it is fully engaged even when peripheral transfers are taking place, and peripheral equipment is kept working at maximum speed. Automatic safeguards prevent interference between programs.

Orion includes a magnetic core working store (capacity up to 16,384 words) backed by several magnetic drum units. Speeds are 36-38 microsec. for addition and subtraction, 60-200 microsec. for multiplication, 300-900 microsec. for division; up to 4.5 million words/min. can be read or written. Cost of the production model will be between $300,000 and $850,000 according to size and scope.

Circle No. 237 on Subscriber Service Card.

New Literature

HONEYCOMB. Hexcel Products, Inc., has just completed a 45-page brochure which is, in effect, a handbook on how to design with honeycomb. Entitled "Honeycomb Sandwich Design," the brochure offers a convenient summary of sandwich design methods complete with formulas and worked-out examples for stress computations on typical sandwich structures. Included are large sections on such aspects of honeycomb construction as Sandwich Theory, Impact, Fatigue, Creep, Environment, Selection of Facings, Selection of Adhesives, Selection of Core Material, Surface Preparation for Bonding, Tooling Methods, Quality Control and many other considerations vital to honeycomb design.

Circle No. 200 on Subscriber Service Card.

SPACE CALENDAR. A "space calendar," listing all U.S. and foreign space shots and supplying a log for similar activities in 1960 has been published by the Avion division of ACF Industries, Incorporated. Avion calls its unique booklet the "Avion Space Year IV 1960 Calendar and Pocket Memo Book" and claims it is the only publication of its type. The inside front cover of the booklet lists all space shots since the first *Sputnik*—October 4, 1957—while the inside back cover is a launch log for shots during Space Year IV (1960). A page is devoted to each month and is marked off with memo space provided for each day. Instead of bold-face marking of such anniversaries as the Fourth of July, Washington's Birthday and so forth, the space calendar is annotated for each space shot during the months they took place.

Circle No. 201 on Subscriber Service Card.

Dr. Donald F. Mitchell: Joins the Astro Systems and Research Laboratories of Northrop Corp.'s Norair Division as a bio-astronautics scientist.

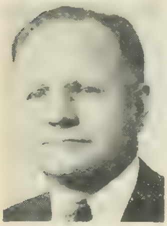

MITCHELL

Dr. Mitchell, who has done extensive research work in genetics, biological effects of radiation, meteorology and botany, will participate in an experimental research program on systems to support human life in outer space.

James D. McLean: Former president of Hoffman Laboratories division of Hoffman Electronics Corp., joins General Dynamics Corp. as president of its Stromberg-Carlson division. Also becomes a senior vice president of General Dynamics and a member of the corporation's board of management. Will assume duties February 15. He succeeds **Robert C. Tait**, who will be associated with the corporate office.

Allan R. Shilts, controller, named to the newly created post of vice president and general manager of the division.

Richard B. Leng: Will head the new defense and industry group concerned with advanced military and industrial electronics at Packard Bell Electronics Corp. The group encompasses the Technical Products Division, the Packard Bell Computer Corp. and the Technical Industries Corp. The new group vice president formerly served as vice president in charge of the Technical Products Division.


LENG

Roger H. Mason: Appointed manager of the newly-formed special products division of Hathaway Instruments, Inc., developers, designers and manufacturers of transistorized inverters, converters and special purpose filters. Was formerly assistant general manager of Hermetic Seal Transformer Co.


MASON

Eugene V. Thatcher: Formerly senior guidance engineer, appointed associate head of the *Atlas* project office of Flight Test Operations at Space Technology Laboratories. Inc.

Previous posts: Western Electric Co., test equipment design; Farnsworth, special projects and mobile communications; Fairchild Guided Missiles Division, *Lark* project, telemetry, controls and guidance radar; and Republic Guided Missiles Division, acting head of electronics section.

Rear Adm. Raymond H. Bass (USN ret.): Joins Bendix-Pacific division of Bendix Aviation Corp., as a staff assistant to R. C. Fuller, vice president and divisional general manager. Adm. Bass' duties will involve anti-submarine warfare and submarine projects currently under way and planned.

Lloyd R. Everingham: Named director of Ryan Aeronautical Co.'s Space Laboratory, with responsibility of operating the newly acquired, wholly owned subsidiary, Aerolab Development Co. of Pasadena. Was formerly vice president-research at Radiation, Inc. and prior to that associated with Cornell University's Aeronautical Laboratory, as a member of the scientific staff and management and as a consultant to the Dept. of Defense, directing numerous studies concerned with missile and warfare system concepts.


EVERINGHAM

R. D. Ginter, *Bullpup* senior project officer and **D. F. Spencer**, *Bullpup* electronics engineer and coordinator of the missile guidance system development and evaluation, received a joint award of $4500 for introducing a radical "no-test-equipment" concept in the *Bullpup* guided missile program. The award was presented by **Rear Adm. Paul D. Stroop**, USN, Chief of the Bureau of Naval Weapons.

William F. Bailey, Richard J. Farber and **Donald Richman:** Appointed associate directors of research at Hazeltine Research Corp.

Bailey will be responsible for military electronic apparatus research; Farber will direct the industrial research division and Richman will head the systems research division. All three have been awarded U.S. and foreign patents for their work in electronics.

Henri Busignies: Holder of more than 100 patents and vice president- and general director of International Telephone and Telegraph Corp., elected a Fellow of the American Institute of Electrical Engineers. The Fellowship was conferred for outstanding contributions in the fields of electronic direction finding, air navigation, radar and radio communications.

James E. Longenecker: Appointed chief mechanical engineer for Magnetic Metals Co., manufacturers of electromagnetic cores and shields for the electronics and communications industries, replacing **Cortis F. Sherman**, retired.

Also, **Henry Kipp** named chief mechanical design engineer, **Eugene Schofield**, chief industrial engineer, and **Raymond Goebel**, tool engineer.

Robert N. Carson, A. Richard Hammer and **Paul E. Pazurek:** Appointed project engineers in the Inet Engineering Department of Leach Corp.

Carson was formerly with International Minerals and Chemical Corp., Libby, McNeill & Libby Co., and Nadar Engineering Co. Hammer was previously with Atomics International, Swanson Engineering & Manufacturing Co., and Midland Rubber Corp. Fisher comes from Rocketdyne Division of North American Aviation, Inc., and the Fisher Body Division of General Motors Corp.

George T. Krinopolis: Named manager, of the Laboratory for Electronics' Computer Products Division's Magnetic Devices Operation. Was previously with Raytheon's components department and prior to that, Brush Electronics.

Edward R. Elko: Former chief engineer at Aerojet-General Corp.'s Systems Division, chosen operations manager-Azusa Operations.

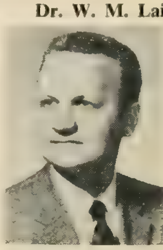
He joined Aerojet in 1947 as a design engineer at the firm's high-thrust engine test station; served as project engineer on the *Nike-Ajax* propulsion system; chief development engineer on the Bomarc propulsion system and was associated with the *Vanguard* satellite program and the Air Force *Thor-Able* and lunar probe vehicles.

William F. Cords: Joins Fruehauf Trailer Co.'s Missile Products Division, manufacturers and designers of ground support equipment.


CORDS

Cord, who assumes a customer relations position in the western division, was formerly director of sales at Airtek Dynamics, Inc., and still earlier, manager of Solar Aircraft Co.'s engine and missile sales division.

Dr. W. M. Lair: appointed director of research and development and **A. H. Haroldson**, associate director of Continental - Diamond Fibre Corp.'s newly completed research and development center in Newark, Del.


LAIR

Dr. Lair was previously technical director at Wrenn Paper Co. and a senior product engineer in development of printed

circuits with General Electric Co.

Haroldson, holder of twelve patents, was formerly manager of research and development at the Newark laboratory.

Robert E. Ringle: former advisor to the general manager, named manager-marketing for Northrop Corp.'s Nortronics division.


RINGLE

Previous positions: executive vice president of Hydro Metal Spinning Corp., general sales manager of Grant Oil Tool Co. and research associate at the California Institute of Technology.

Raul H. Frye: Appointed general manager and **J. Alan Stewart,** operating manager of Sparton Corp.'s Electronics Division.

Frye, formerly assistant general manager and marketing manager of Fairchild Camera & Instrument Corp.'s Defense Products Division will direct divisional sales and marketing programs. Stewart, former production manager at Loral Electronics Corp., is responsibile for the general administration of in-plant operations, including manufacturing and administration of military contracts.

Jennings David: Named vice president-Engineering for Summers Gyroscope Co. Was previously one of the engineers who developed the *WAC* and *Corporal* missiles.

Stanley E. Rendell: Elected vice president and assistant general manager of The Hallicrafters Co. Prior to joining the firm in 1956 as director of manufacturing, he was chief industrial engineer with Belmont Radio Corp.

Victor H. Soucek (Capt. USN ret.): named to the new post of manager of special projects for Sanders Associates, Inc., responsible for special development programs for weapon systems and missile defense.

Ernest N. Robinson: Former director of marketing appointed general manager of the Alemite and Instrument Div. of Stewart-Warner Corp., succeeding **W. A. Brown, Jr.**

H. Paul Sherlock: Elected sales manager of ENFAB, Inc., manufacturer of moulded compressible fiber-glass.

Dr. Murray Bloom: Formerly with American Potash & Chemical Co., joins Pacific Semiconductors, Inc., to assist **Dr. T. C. Hall** in semiconductor surface research studies.

George E. Stoll and **A. P. Fontaine:** elected executive vice presidents of Bendix Aviation Corp. Both are directors of the corporation and members of its administration committee.

Stoll will direct 24 U.S. divisions and subsidiaries, with headquarters in Detroit.

Fontaine will be responsible for many staff functions, including engineering and research, sales, planning, product development and patents.

The following appointments have also been announced:

Raymond C. Culbertson: named general manager of the defense products division of American Air Filter Co., Inc.

Milton B. Ames, Jr.: former assistant director of research for Aeronautics and Flight Mechanics, elected deputy director of the office of Advanced Research Programs at NASA.

E. Haynes: former deputy director of Aeronautical Sciences, USAF Office of Scientific Research, ARDC, becomes program manager, Exploratory Research and Reliability Branch, ARPA.

Samuel J. Levine: Manager of General Electric's Aircraft Nuclear Propulsion department test operation at Idaho Falls, Ida., named manager-projects for the department. **Dr. John W. Morfitt,** manager of ANPD nuclear development laboratories will succeed Levine.

Frederick M. Geiger: appointed manufacturing manager-potentiometers and **Joseph Katona,** manufacturing manager-instruments and systems at Daystrom's Pacific Division.

Howard T. Sterling: elected chief engineer of EPSCO, Inc.'s Worcester division.

Kenneth A. Dunn: named manager of administration for range systems operations at Aeronautics division of Ford Motor Co.

John D. Van der Veer: appointed to the newly created post of manager of government relations at Tung-Sol Electric Inc.

W. Lawrence Brantley: elected manager of Giannini Controls Corp.'s Washington district.

Dr. Nils L. Muench: formerly a senior research engineer with Humble Oil and Refining Co.'s production research division, named chief scientist of the Army Rocket and Guided Missile Agency.

Joseph M. Dukert: becomes manager of Information Services for the nuclear division of The Martin Co.

S. P. Smith: elected assistant director-engineering at Bendix Aviation Corp.'s products division. **R. A. Trapp** succeeds Smith as manager of engine equipment sales.

Computer Control Co., Inc., announces the following appointments: **D. J. Ryan,** formerly with AVCO's research and advanced development department, Administrative Staff Engineer; **L. A. Gutwill,** of M.I.T. Instrumentation Laboratory, to Development; **A. J. Winitzer,** formerly with American Standard's Military Product Systems Design department, Systems Project Engineer; and **R. Capraro** of ACF's Avion division, as electrical engineer assigned to systems.

AAS Hits Variety of Space Subjects

The Sixth Annual Conference of the American Astronautic Society in New York, Jan. 18-21 saw a good variety of technical papers presented on the astronautical sciences.

As a service to MISSILES AND ROCKETS readers, the papers have been condensed into abstract form for easier reading. Copies of the papers may be obtained from AAS's New York office.

Transmission Efficiency Between Simple Antennas on the Basis of Orientation and Polarization, John B. Rankin, RCA Laboratories, Princeton, N.J., Preprint No 105.

The object of this project is to determine the effect of random orientation of simple antenna systems, such as might be used on a satellite, on transmission efficiency and hence communication reliability.

Some Control-Display Aspects of Manual Attitude Control in Space, Malcolm L. Ritchie, Lewis F. Hanes, Ritchie and Associates, Inc., Dayton, Ohio, and Thomas E. Hainsworth, Lear, Inc., Preprint No. 60-14.

An investigation was conducted to determine the ability of a human operator to control the attitude of a simulated exoatmospheric vehicle using several different combinations of displays, controllers, and control systems. The displays were a three-axis, moving sphere-type attitude indicator with and without body-axis rate indicators. Three controller arrangements were studied—individual hand controls for each of the three axes, a three-axis integrated controller, and a combination of the integrated controller and foot pedals. Proportional and on-off controls were used with the integrated controller.

The operators were instructed either to (1) stop the attitude spin or to (2) stop the spin at a particular attitude. They were able to stop the spin with an efficiency of about 90% and in less than 10 seconds with the best control-display combinations.

On the Simplification of the Attitude Equations of a Satellite, C. T. West and R. Goodstein, Boeing Airplane Company, Seattle, Preprint No. 60-13.

A technique for the simplification of the attitude equations of motion of a satellite, for the purpose of synthesizing an optimum control system, is discussed and illustrated.

The low torque levels involved in applied, inertial reaction, and cross-coupling terms require consideration of the complete equations of motion for each mathematical model selected. The resulting equations can be reduced to workable size by comparing the magnitudes of terms in order to select a set of simplified equations.

Application of Lunar Theory to the Motion of Satellites, Paolo Lanzano, Space Technology Laboratories, Inc., Los Angeles, Preprint No. 60-33.

The Lunar Theory of Celestial Mechanics is applied to the problem of establishing a permanent artificial satellite on a periodic orbit around a planet.

Using a method developed by C. L. Siegel, in his "Vorlesungen uber Himmelsmechanik," the Hill's equations of the Lunar Theory are solved to obtain the coordinates of the periodic trajectory as Fourier series of the time with respect to a rotating system of reference. A recurrent procedure is obtained for evaluating the coefficients of the series in terms of the period of revolution. The Jacobi constant of the motion is also expressed as an infinite power series of the period. The convergence of such expansions can be ascertained for small values of the period. A numerical example for a satellite of Venus is furnished.

An error analysis is undertaken by studying solutions of Hill's equations lying in a neighborhood of a periodic orbit and corresponding to the same value of the total energy. The coordinates of such neighboring trajectories are determined as isoenergetic displacements referred to the intrinsic reference formed by the tangent and normal lines at the various points of a periodic orbit. This procedure leads to a differential equation of the Mathieu type whose solution is obtained as a series expansion valid for small values of a parameter.

Kinematics of Planetary Ballistic Probes (Comparative Results of Keplerian ARCS vs. 3-Body Problem), M. Yachter, ARMA Division, American Bosch Arma Corporation, Garden City, N.Y.

This paper deals with the determination of theoretical relations and procedures of calculation leading to the determination of proper injection conditions for ballistic planetary probes on an interception course.

The Effect of Non-uniform Magnetic Fields on Internal Flows of Conducting Fluids, A. Sherman, Flight Propulsion Laboratory Department, General Electric Company, Cincinnati, Preprint No. 60-56.

The paper considers the flow of an inviscid, electrically conducting fluid through a straight two-dimensional channel subject to a non-uniform magnetic field. The fluid is assumed to be incompressible, have constant properties and a zero Magnetic Reynolds number. A solution is obtained for the 1st order approximation and the equations for higher order approximations are given. Numerical results are presented which describe the velocity and temperature throughout the flow field. In particular, the velocity, temperature and pressure along the wall where the interaction is greatest is presented.

An Astrovehicle Rendezvous-Guidance Concept, R. S. Swanson, N. V. Petersen, L. R. Hoover, Astrosystems & Research Laboratories, Norair Division, Northrop Corp., Hawthorne, Calif., Preprint No. 60-12.

A system concept utilizing a moderately sophisticated control-computer system is proposed for the rendezvous operations required for space station assembly, maintenance, repair and modification of orbital devices, and for resupply of manned and unmanned space systems. The proposed rendezvous guidance system is fairly tolerant of launch guidance errors, especially of the delays in launch time which will probably cause difficulty during the early attempts at rendezvous operations.

The proposed concept, defined as a quasi-optimum rendezvous guidance system (QORGS), allows the use of efficient orbital maneuvers for correction of the larger injection guidance or launch time errors, as well as the less efficient homing-type guidance for the final "docking" phase of the rendezvous operation. Rendezvous operations are expected normally to be completed in one satellite orbital period, using the proposed system concept.

The Oblatory Perturbations of Satellite Orbits, N. S. Hall, H. F. Gawlowicz, General Electric Company, Defense Systems Department, Syracuse, N.Y., Preprint No. 60-29.

The results of a mathematical study of the orbits about an oblate earth are given. These results were obtained by a modification of the method of variation of parameters which avoids the singularity at zero eccentricity normally associated with such techniques. Dependence of the variables upon initial conditions is completely given.

Comparison with numerical integration is shown which indicates errors of .03 nautical miles for very small eccentricities over 60 circuits of the orbiting vehicle. Since the results are in the form of a truncated power series in e, and J^2 is neglected, these errors increase to .2 miles on the fortieth circuit for $e = .1$ and .5 miles on the first circuit for $e = .25$.

The use of Vegetable Cultures as the Photosynthetic Component of Isolated Ecological Cycles for Space Travel, Linvil G. Rich, William Marcus Ingram, and Bernard B. Berger, Preprint No. 60-25.

Man's exploration of space will be limited by his physiological requirements. Although dehydrated foods and tanked water and oxygen will suffice for space flights of relatively short duration, long-term operations will be possible only if these necessities can be derived from the environment within the space vehicle. Conservation of environmental mass will make mandatory some type of closed ecological system kept in operation by a source of continuous energy. Conceivably, such a system will involve a carbon-dioxide exchange between humans and plants, waste reutilization, and the growth of plants for human consumption. Items on the original inventory will be used again and again for the continued sustenance of man.

Higher plants have long been a primary source of human food material. Many people exist entirely on vegetable diets, the preparations of which require only cleaning and cooking. Moreover, the growth of some higher plants in soilless culture under partially controlled conditions is already accepted commercial practice.

It appeared desirable to make a study of the use of higher plants as the photosynthate in the human sustenance system. The present paper discusses the results of such a study.

Heat Rejection From Space Vehicles, Daniel P. Ross, Edward Ray, and Henry C. Haller, Space Power Systems Group, Research and Engineering Requirements Tapco Group, Thompson Ramo Wooldridge Inc., Cleveland, Preprint No. 60-39.

The discussion devotes major emphasis to heat rejection from a vapor power cycle, considering both the condenser and radiator. Information is also presented which is applicable to heat rejection from other powerplant cycles, or from other space cooling applications. Data is presented to indicate important parameters and trends associated with space radiators.

Basic Requirements for the Exploration of Jupiter and its Moons, Warren H. Straly, Robert G. Voss, Preprint No. 60-57.

This paper is concerned largely with the compilation of knowledge made available from studies of physical phenomena concerning Jupiter, and the application of this knowledge to the areas of space-flight mechanics and space system design. These two broad areas serve to form a basis for the investigation of the requirements

necessary for exploration.

Communications and data transmission, guidance and control, auxiliary power sources, and flight environment are examined in the light of energy requirements, trajectories, orbital navigation, large transfer times, vehicle capabilities, mission objectives, and payload characteristics.

Ecological Criteria for an Interstellar Rocket Relay Station, R. E. Ross, General Dynamics Corporation, Electric Boat Division, Groton, Conn., Preprint No. 60-23.

The problem of assessing the overall efficiency of men and mechanical equipment confined in a limited space such as an interstellar relay station requires a precise workable approach. The rewards for making the problem accessible to mathematical treatment are several. Not only may a general formula for approximating spatial requirements be derived, but it is also possible to set up dependable functional equations for such seeming imponderables as human caprice, chance interactions between men and equipment owing to externally-induced accidents, and system depreciation.

By appropriately varying the values of coefficients and weighted exponents in a large-scale factorial design, by testing simulated models of man-machine interface, and by monitoring the analogs of pulsed synapses (varying the time and the induced-effect inputs), one can determine a system's operating potential, information entropy, and economic value.

A Celestial Moving Target Indicator, H. Dubner, Manager, Advanced Development Laboratory, Avion Division ACF Industries, Inc., Paramus, N.J., Preprint No. 60-19.

Existing state-of-the-art components are available to provide a Celestial Moving Target Indicator with a 30-degree field of view. The most serious single degrading factor is the persistence characteristic of the P-7 phosphor. Development of a special phosphor more suited for this application would extend the range capability from the order of thousands of miles to tens of thousands of miles. The technique offers sufficient promise to warrant continued development toward demonstration equipment.

One-Way Reconnaissance to Mars, J. Victor Hughes and George N. Nomicos, Republic Aviation Corporation, Scientific Research Staff, Farmingdale, N.Y., Preprint No. 60-50.

A one-way reconnaissance mission to Mars, starting from the earth's surface and placing a payload (including guidance and control equipment) of 6000 lb. into an orbit round Mars, is considered. Take-off from the earth's surface may use a chemical or a nuclear rocket, while the interplanetary journey may use a chemical or a nuclear rocket, or an electric propulsion system (plasma engine or ion engine). The total take-off weight is calculated for each likely combination of these engines.

A nuclear rocket for take-off gives a take-off weight about one-fifth of that needed when using a chemical rocket. Least take-off weight is required by a system using a restartable nuclear rocket engine for all stages, but it is unlikely that such an engine will be available in the foreseeable future. The most attractive combination, from joint consideration of low take-off weight and reasonable availability date, is:

Nuclear rocket to place the vehicle in an orbit round the earth, with electric propulsion for the remainder of the journey.

Navigation and Energy Display Requirements for Pilot-Controlled Satelloid Flight, R. C. Kaehler, Consultant, S. Romano, Program Manager, Avion Division ACF

Industries, Inc., Paramus, N.J., Preprint No. 60-26.

This report covers a discussion of information requirements for a piloted satelloid system while on an orbital bombing mission. Recent experimental data are presented regarding pilot capabilities for vehicle reentry control and problem solving activities while exposed to high-magnitude accelerations.

Special emphasis is given to combining present and future navigation and energy information for the re-entry and approach-for-landing phases of flight.

An Earth-Oriented Communication Satellite of the Passive Type, Warren Gillespie, Jr., NASA Langley Research Center, Langley Field, Va., Preprint No. 60-4.

A passive communication satellite for global communication is described in which the reflecting surface is an erectable spherical segment of a very large sphere (which as a complete sphere would be impractical to build) and the segment is oriented continuously toward the center of the earth. Use of the spherical segment is proposed as a compromise between the low reflecting efficiency of a smaller complete sphere and the high pointing accuracy required for a plane reflecting surface.

A Survey of Ion Sources for Electrical Propulsion, K. M. Foreman, Republic Aviation Corporation, Farmingdale, L. I., New York, Preprint No. 60-7.

A brief introductory analysis of electrical propulsion for space travel shows that flight duration is inversely proportional to the square foot of thrust. The engine thrust appears to be a strong function of ion accelerating potential, ion chamber size, and to a lesser degree the ion charge. The effect of ion mass on thrust is shown for various design considerations such as fixed geometry and exit velocity, fixed chamber geometry and accelerating potential, and constant ion current and accelerating voltage. Space charge effects are also considered.

Ion source requirements are: a) high purity, b) low power consumption, c) excellent stability, d) simple control, and e) large current density.

An historical review of five types of ion production is presented along with salient features of each method.

Nuclear Rocket Engine Control Problems in an Upper Stage Interplanetary Vehicle, B. P. Helgeson, Reaction Motors Division, Thiokol Chemical Corporation, Denville, N.J., Preprint No. 60-9.

It is assumed that the mission for a nuclear rocket upper stage is the transportation of a sizeable payload from a 300-nautical-mile earth orbit to a 300-nautical-mile Mars orbit.

A nuclear engine system of the solid-fuel, heat exchanger type is assumed and briefly described.

Problems of ground checkout, boost, duty cycle and shut down are discussed.

The generalized thrust duty cycle is characterized by rapidly applied values of impulse in the initial and terminal phases with intermediate navigational requirements for low-power operation. The inherent flexibility of operation of the nuclear engine is shown to be attractive for this mission. The need for a simple controls system which does not detract from the characteristic high performance of the nuclear engine is emphasized.

The Operational Support of Space Vehicle Missions, Herbert S. Dordick, Airborne Systems Division, Defense Electronic Products, Radio Corporation of America, Camden, N.J., Preprint No. 60-52.

This paper describes an operational analysis program which is presently underway, and which projects maintenance and support requirements for future space vehicle systems.

Vehicle mission profiles are defined and classified into families according to the electronic system complexity and maintenance requirements. Much can be learned about the support and maintenance philosophy most suitable for a family of vehicles without a detailed knowledge of specific equipments. The inter-relationships among the support goals, cost, logistics, and reliability are delineated. Some of the key trade-offs developed are shown and discussed. The logical extension of the program is discussed and some future results are predicted.

Nuclear Power Plants for Space Vehicle Application, Sherman Naymark, Atomic Power Equipment Department, General Electric Company, San Jose, Calif.

The author says nuclear energy appears to be the most suitable source for auxiliary power in space vehicle. Nuclear power sources produce more power per weight and lifetime than comparable energy sources.

A long-life auxiliary power plant on a space vehicle will have a marked effect on the utility of that vehicle and in many respects will determine the feasibility of its mission. Both dynamic and static conversion equipment can be used with nuclear heat sources.

Methods of Predicting Radiation Dosage in Space Flight, Angus F. Bond, Michael G. Del Duca, and Andrew D. Babinsky, Advanced Systems Group, Research and Engineering Requirements Tapco Group, Thompson Ramo Wooldridge Inc. Cleveland, Preprint No. 60-21.

This paper presents suggested computational methods for evaluating whatever techniques may be provisionally selected. Some of these methods point toward development of vehicle instrumentation which may eventually become operational for man's defense against the radiation danger. Systems for early warning to the crew and guidance corrections for radiation avoidance or for trajectory optimization, on the basis of newly received information, are among the concepts used.

Aerobic Biological Degradation of Human Waste in Closed Systems, Richard H. Bogan, University of Washington, Seattle, Wash., David D. Chapman, Boeing Airplane Company, Lowell H. Ericsson, Boeing Airplane Company, Seattle, Wash., Preprint No. 60-27.

The demonstration that activated sludge cultures can function at some 300 times the concentration of normal sewage, constitutes a basis for the view that reliable biological methods of waste reduction, with small weight, space and power requirements, can be developed for extended space flights or for extraterrestrial manned stations.

Multistage Rocket Staging Optimization, Ramon L. Chase, Chrysler Corporation, Missile Division, Detroit, Mich., Preprint No. 60-41.

This paper presents equations for optimizing vehicle staging on the basis of maximum performance. It is believed that this optimization technique is unique in that the usual assumption of constant required characteristic velocity is not utilized. The interdependence of the required missile characteristic velocity, V_r, and the staging is included the use of a truncated Taylor expansion of V_r. The inclusion of the dependence of V_r on vehicle staging enables the trajectory and vehicle to be optimized as a single system for the first time.

The results of this technique are illustrated by the optimization of a three-stage escape vehicle.

Equations are also presented for the optimization of staging on the basis of minimum cost per pound of payload.

propulsion engineering . . .

By JAY HOLMES

Four key Aerolab executives . . .

are moving over to Atlantic Research. General Manager Hal F. Halstead and three others will set up an Atlantic Research space vehicle group at Pasadena. They will be put to work on plans for staged vehicles based on available rocket motors able to attain orbital trajectories and escape velocities.

Obviously, Halstead's team is leaving as a result of the sale of Aerolab to Ryan Aeronautical last month. Others in the group are David Benun, chief engineer; John W. Reed, Jr., sales manager; and Joseph Baltrush, comptroller.

The Aerolab team gained fame last year for its part in the Jason phase of the Project *Argus* nuclear explosions in space. Aerolab vehicles were used for probes that measured the effects. They also assembled the *Javelin*, a four-stage rocket consisting of an *Honest John*, two *Nikes* and an *X-248* with a 1000-mile vertical range, and the *Journeyman*, a combination of a *Sergeant*, two *Lance* motors and an *X-248* with a 2000-mile vertical range.

Atlantic Research proposes to make use of the Aerolab team's know-how in assembling its own multi-stage vehicles. The market for sounding rockets is growing, Atlantic Research says, and it wants to capitalize on it. There is some speculation that ARC rockets might be staged too. However, the staging of end-burning rockets might introduce problems.

Speaking of sounding rockets . . .

Thiokol reports its *Cajun* rocket engines are now available for immediate delivery off the shelf from its Elkton, Md., division. Cost: $1286 apiece. Production of the 1000th *Cajun* was recently announced.

The rocket comes in three models. Model I, 108" long and weighing 172 lbs., was used extensively in the International Geophysical Year program. Model II, 107" long and weighing 171 lbs., was developed with General Electric Co. for rocket sled propulsion. Model III, 104" long and weighing 166 lbs., was designed for use in the *Pogo-Hi* target missile system. All are 6¾" in diameter and generate 8100 lbs. thrust for 2.8 sec.

Mach 7 wind tunnel velocities . . .

have been achieved at the Naval Supersonic Laboratory at the Massachusetts Institute of Technology. These speeds, which double the velocities previously achieved in the tunnel, were made possible by placing a small hypersonic tunnel into an existing lower-speed supersonic tunnel. Installation of the hypersonic nozzle cost about $150,000.

Titanium mill shipments rose 20% . . .

in 1959 as prices continued downward, Titanium Metals Corp. reports. About 15% of the metal shipped was earmarked for missiles and another 15% went for civilian applications. The remainder of the market was manned military aircraft, which creates uncertainty in the 1960 market. Mill shipments in 1959 totaled 3100 tons. The composite price, based on sheet, strip, bar and billet was $7.22 per lb. at the year's end, compared with $8.66 at the end of 1958.

Disintegration barrier . . .

a hitherto unrecognized barrier to space travel, has been pinpointed by Dr. Elliot T. Benedikt, a Northrop Corp. physicist. Benedikt told the American Astronautical Society space ships would disintegrate on reaching a certain critical velocity as a result of collisions with microscopic intersteller dust particles.

The barrier is no problem with presently projected vehicles, however. It comes into play only at 99.5% of the speed of light.

$30-Million *Mercury* Range Contract Signed

Cost of the globe-girdling *Mercury* tracking range has been placed at about $30 million under the terms of a cost-plus-fixed-fee contract signed by NASA and a team headed by Western Electric. Negotiations were completed Jan. 18.

The 18-site network to track the first U.S. astronaut in orbit is to be completed in 1961. Major members of the team are Bell Laboratories, Bendix Aviation and Burns and Roe Inc.

Western Electric is responsible for managing the project as well as the design and implementation of ground communications. The company also will make arrangements for intersite communications and train the operations and maintenance personnel.

Bell is handling the basic systems engineering for communications and visual presentation of the manned capsule. It also is in charge of equipment compatibility and will provide consultation in radar.

Two divisions of Bendix are involved in the project. The Radio Division is providing ground-to-capsule voice communications equipment, radar equipment and ground command links. The Bendix-Pacific Division will provide the telemetry receiving system, associated command-display consoles, and data-processing equipment for the entire network. The system will utilize more than 90 data channels.

Burns and Roe, an architectural and engineering firm, is the designer and general contractor for all construction, including two shipboard installations. The 18 sites are located at Cape Canaveral, Grand Bahama Island, Grand Turk Island, Bermuda, the Canary Islands, Western Australia and Southern Australia, Canton Island, Hawaii, White Sands, N.M., in southern Texas, Eglin AFB, Fla., at two locations in Africa, at two locations on the West Coast of the United States, and aboard two radar picket ships—one in the Atlantic and the other in the Indian Ocean.

A computing and communications center for the network will be located at NASA's Goddard Space Flight Center, Beltsville, Md. The control center will be at the Cape, which is the launch point.

Lacrosse Gone to Canada For Joint Arctic Testing

HUNTSVILLE, ALA.—The Martin *Lacrosse*, surface-to-surface field Army missile, has migrated to Fort Churchill, Manitoba, during January and February for tests under arctic conditions.

Aerojet to Build 2n

ABOVE: Interior view of the cast and cure building at Aerojet-General Corp.'s Sacramento plants. Upper level is 3700 sq. ft., removable platforms total 3700 sq. ft., and lower level is 7750 sq. ft. BELOW: Note huge earthworks.

Aerojet-General Corp. will produce the second-stage propulsion unit of the *Minuteman* ICBM, subject to successful tests of hardware, the Air Force announced last week. Thiokol Chemical Corp. drops to a limited technical backup.

The amount of money involved in the second stage was not disclosed, but Aerojet said last year it had been awarded an $85-million contract for R&D on all three stages of *Minuteman*. At the time, Aerojet had a limited backup on the first stage. Last fall, however, AF made Thiokol sole source.

Early last month, AF reportedly decided that Aerojet would have sole-source status on the second stage. The decision was delayed for two weeks after congressmen and other Utah political leaders protested.

Congressional sources said AF felt that Aerojet and Thiokol work was about on a par. Aerojet was chosen, these sources said, because it was thought both stages should not be concentrated in the same company and the employment involved should be spread to as many areas as possible.

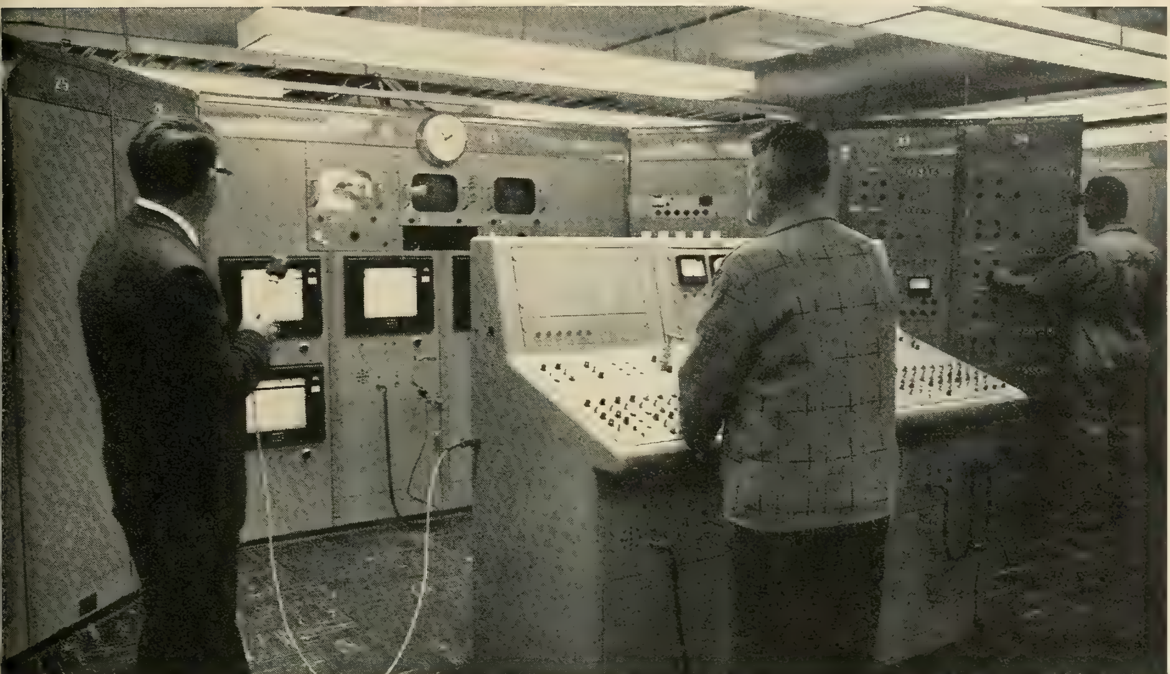
In its announcement, AF said the Thiokol first-stage plant at Brigham City, Utah, will employ 1300 to 1500 at peak production, and the assembly facility at Hill AFB, Ogden, Utah, will employ over 800.

Aerojet and Hercules Powder Co. still are in contention for the third stage. Other *minuteman* contractors are Boeing, assembly and test; Avco, nose cone; and American Machine & Foundry and ACF Industries, railroad cars for mobile version.

Aerojet will produce *Minuteman* second stages at the ultramodern Sacramento, Calif., facilities shown in the accompanying photographs.

tage of *Minuteman*

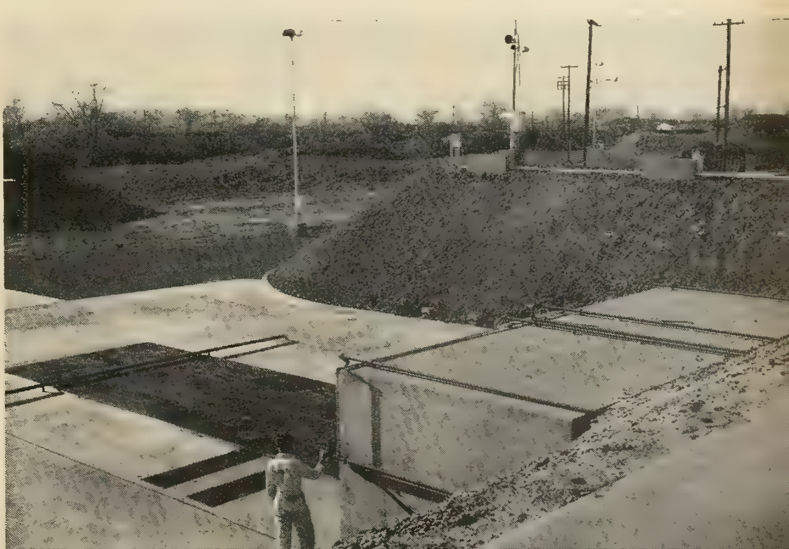
A look at its huge casting, curing and core preparation complex



CONTROL CENTER from which Aerojet operates three static test stands for the *Minuteman's* solid rocket motors. The center uses the most advanced instrumentation equipment. Test results, monitored on 300 channels, can be available to the test engineer in less than four hours.

LEFT: One of the static test bays. Head wall, at center, is 8 ft. high, 11 ft. thick and made of poured concrete reinforced with steel rods. Concrete floor is 6 ft. thick.

RIGHT: Close-up of bay. During testing, motor is bolted to black motor stand and connected to white head wall thrust plate. Plate is four-in.-thick steel to take force of blast.



by M/R Staff
From Official Translations

Meteorite Information

Some meteorites have been found to contain minerals not present in the Earth's crust, the USSR Meteorite Commission was recently told.

I. A. Yudin, Candidate of Geological and Mineralogical Sciences reports that these minerals have been formed artifically during metallurgical processes. Through study of this phenomena he hopes to provide an answer in regard to the formation of meteorites, asteriods, and planets. *(Sovetskaya Rossiya, Dec. 13, 1959, p. 4, cols. 5-6.)*

Titanium Electrolysis

Several laboratory experiments have demonstrated the possibility of refining titanium by electrolysis of molten media with soluble anodes. A. B. Suchkov reports complete separation of binary Ti-Fe, Ti-Si and Ti-Nb alloys in molten alkali chlorides, electrolysis of enriched and deoxidized high-Ti materials such as ilmenite slags or ore concentrates, electrolysis of titanium oxide, carbide or nitride, and the processing of metallurgical slags with high Ti content. (Tsvetnyye metally No. 6 and No. 8, 1959.)

Thermoelectric Cooler

A Soviet Authors' Certificate has been issued to A. G. Shcherbina, A. G. Tauber, and I. G. Mushkin for a small thermoelectric cooler which reportedly facilitates a more complete and reliable removal of heat from the warm lower junctions of the thermoelectric pile.

The specific feature of the unit, according to an article in Byulleten' izobreteniy (No. 16, 1959, p. 81), is a system of air radiators—located around the operating chamber in an open housing—which is fanned with a vane-type fan fixed on the axis of an electric motor.

Lithium Resistance

According to an article by Yu. F. Bychkov, A. N. Rozanov, and V. B. Yakovleva in the journal *Atomnaya energiya* (Vol. 7, 1959, pp. 531-536), experiments have been conducted on uranium, zirconium, iron, nickel, titanium, molybdenum, niobium (columbium) and beryllium in liquid lithium at 700-1000°C to determine the solubility of these metals and their resistance to liquid lithium.

The mechanism of corrosion also was studied. The experiments were conducted with materials specially purified in a device described and illustrated in the source.

The experiments consisted in filling crucibles (made from the metal to be tested) with lithium in an inert atmosphere of argon, and heating them for several hundred hours at a given temperature. The transfer of impurities and dissolving of the metals onto the inner surface of the crucibles was observed with crucibles made of "Armco" or some Soviet stainless steels.

It was further observed that lithium can be purified by using zirconium and uranium.

The results, according to the article, permitted classification of the tested metals according to their solubility in lithium. Nickel and beryllium were determined to be of high solubility of the order of 0.1%. Iron, zirconium, titanium and uranium proved to be less-soluble (hundredths of thousandths of 1%). Niobium (columbium) and molybdenum proved to be highly insoluble, less than 10^{-4}%.

Nickel Base Alloys

When complex nickel-base alloys are cooled from high temperatures, a partial decomposition of the solid solution occurs under precipitation of a phase with the same lattice parameters as those of the basic solution, but with a different content of alloying elements.

According to an article by I. I. Titarenko and B. M. Rovinskiy in the Fizika metallovi metallovedeniye (Vol. 8, No. 5, 1959, pp. 731-734), diffusion occurs at 1125°C, causing separation of the lattice. Holding at 1200°C causes some of the components of the precipatated phase to diffuse back to the basic solid solution.

Cold Welding Aluminum

I. M. Stroyman in Svarochnoye proizvodstvo, (No. 12, 1959, pp. 6-9) states that experiments at the All-Union Scientific Research Institute of Electric Welding Equipment reportedly demonstrated the feasibility of cold spot-welding for sheets of an aluminum alloy consisting of 4.80 magnesium, 0.43 manganese, 0.44 vanadium, in thicknesses up to 2+2 mm.

The maximum weld strength corresponding to 80-90 percent of thickness reduction is achieved at 20 kg/mm² of specific pressure. The yield strength of the base sheet is 16 kg/mm².

Another alloy with 6.80 magnesium, 0.62 manganese, and 0.23 titanium, showed considerably poorer weldability.

Double-Message Modulation

The Soviet publication *Elektrosvyaz'* (No. 12, 1959, pp. 17-27), discusses the basic principles and merits of double-message amplitude modulation for simultaneous transmission of two signals by one carrier.

Designated "dvustoronnaya modulyatsiay," in this type of modulation all positive half-waves of the carrier are modulated by the first signal to be transmitted and all negative half-waves by the second signal.

The signals are separated in the receiver by two oppositely connected detectors.

According to the article, a Soviet patent for this method was originally issued to V. K. Kenigson and G. N. Markov in 1936, but did not find practical application because it required a wide frequency band. Recent interest, according to the article, is explained by "the appearance of several problems related to the simultaneous transmission of two signals where double-message modulation may lead to successful solutions."

High-Power Tubes

According to an article by P. N. Andreyev and N. V. Zaryanov in the Soviet publication *Svyaz'izdat* (1959, p. 110), Soviet specialists have developed two new high-power transmitting tubes. One, designated PT-500, is for broadcasting and communications. The other, 20-C-300, is for short-wave communications. Basic electrical data on these tubes are:

PT-500

Filament voltage	30v
Filament current	700a
Plate voltage	10v
Saturation current	350a
Transconductance	150ma/v
Gain	28
Maximum dissipated plate power	300 kw
Maximum dissipated grid power	35 kw

'0-C-300

Filament voltage	33v
Filament current	500a
Plate voltage	10-20 kv
Saturation current	100a
Transconductance	60ma/v
Gain 45	
Maximum dissipated plate power	150 kw

Under "favorable conditions," the PT-500 series reportedly can deliver 500 kw of h-f power. The cathode system is of a three-phase type, advantageous because of the considerable decrease in hum, produced by the pulsation of filament current. Parallel distribution of filament groups in each phase was recommended for minimizing the magnetron effect by mutual compensation of the magnetic fields.

The 20-C-300 tube under optimum conditions can obtain h-f power of 300-500 kw. Cathode life is rated at 5000 hours. Special measures have been taken to minimize parasitic inductances for successful operation in the 8-10-m band.

The development of the new tubes was credited to scientists and engineers A. L. Mints, A. M. Kugushev, S. A. Zusmanovskiy, N. I. Oganov, P. N. Andreyev, M. I. Karpovskiy, and M. I. Basalayev.

Thermal Expansion Tests

An accelerated method of determining the thermal expansion of some metals, alloys, and ceramics has reportedly been found, according to an article by V. G. Bravinskiy and Ye. G. Bravinskaya in the publication *Savodskaya laboratoriya* (Vol. 25, No. 11, 1959, pp. 1336-1338).

Among the metals tested, molybdenum, Kovar and "Khronin" (otherwise unidentified) are mentioned. According to the table of results given, the coefficient of thermal expansion of "Khronin" is about three times higher than that of molybdenum.

Among ceramics an alumosilicate and a cordierite were tested. The report states that the alumosilicate was very close in expansion properties to molybdenum, while codierite showed much lower results.

Materials were tested in the temperature range of 20-500°C on a universal Leitz dilatometer. Deviation from results obtained by standard methods did not exceed 3.10^{-7} per $°C^{-1}$.

The advantage of the method, according to the article, is that it saves considerable time. It is said to take only 40 minutes instead of the normal 8¼ hours for glass or ceramic, and 2¾ hours for metal. Moreover, the same device can be used for both types of materials to give comparable results.

soviet affairs . . .

By DR. ALBERT PARRY

The Pacific Ocean may be . . . a new target area for Russian rocket explosions, but it is not new territory for Russian sub and rocket bases. In addition to the missile installations known to exist on Russia's own Far Eastern shores near Vladivostok, we have it on Nikita Khrushchev's authority that Red IRBM's are in position in China, facing the ocean.

He revealed this . . . last June 23 to Averell Harriman, during the latter's visit in Moscow. Khrushchev declared that he had sent numerous rockets to Red China, and these had been installed in the hinterlands behind the coastline, with enough range to blast the Chinese Nationalists on Formosa and to threaten, "immobilize and, if necessary, destroy" the U.S. Seventh Fleet patrolling the Formosa Strait.

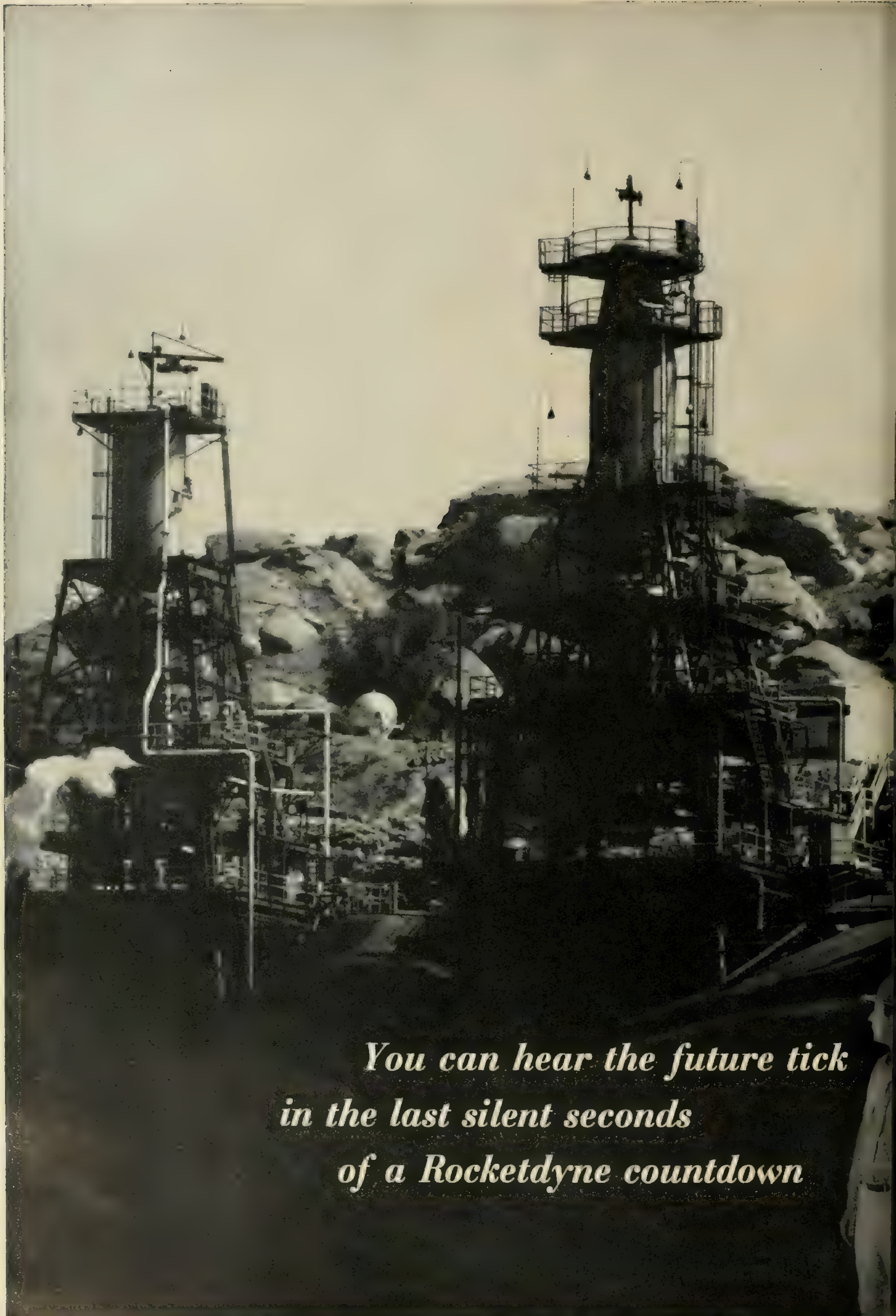
Less publicized are the reports . . . from sources other than Moscow that farther south along the Pacific shore the Reds have bases for submarines, and that some of these subs are missile-equipped. According to Western intelligence sources, one such base was established in the mid-1950's, soon after the Red victory in North Indochina, when the former French naval station at Haiphong, southeast of Hanoi, was handed over by the Communist government of Ho Chi Minh to the Russians.

The Haiphong base . . . was at once utilized by the Soviets for their submarines, now lying in a river delta amid dense jungle affording good camouflage from any hostile or prying aircraft. Another such Red point of departure in the Pacific is the Coushan Islands, near Shanghai, given by the Red Chinese to the Soviets for a strong naval base, particularly for submarines and their missiles. At about the same time the Soviet government "turned over" to the Red Chinese a few of its submarines. It is possible, however, that most of the crew members on these "Chinese" subs are Russians, or that at least the subs' commanders and key missile-handling personnel are Russians.

Indonesian ports . . . are among the latest points of interest for the Soviet military. Last November a squadron of Russian cruisers based at Vladivostok visited Djakarta and other ports along Indonesia's shores. Much was made of this trip by Soviet propagandists accompanying the squadron, and by the Indonesian Communists and fellow travelers awaiting them. Articles in the Moscow military press describing the allegedly overwhelming success of this visit to Indonesia inevitably included anti-American sallies, chiefly on the subject of the "waning" of U.S. influence in the Pacific. Typical was Lt. Col. A. Leontyev's article. "In the land of 3000 Islands," which appeared in *Krasnaya Zvezda*, the main organ of the Soviet Ministry of Defense, for last December 13.

This Red naval excursion . . . into the Pacific is presented by the Soviet colonel and other Russian writers as an entirely peaceful enterprise. We can be sure, however, that rocketry specialists were included on the staffs of the Red squadron, and that much valuable reconnoitering was done in that area of the Pacific, no less than in other parts of the ocean, prior to the announcement that Soviet rockets would from now on begin to explode so far away from Russian shores.

Old Russian exploits in Hawaii . . . are now being recalled by Moscow's men as their rockets reach into Central Pacific. In 1815-17 Dr. Georg Anton Scheffer, a German adventurer in Russian employ, built forts on Hawaiian shores and raised the Russian flag over them. He swore a native ruler, King Tomaree, into allegiance to Tsar Alexander I, and wrote to the tsar: "The Sandwich Islands are the keys to China, Japan, the Philippines, India and the Northwest Coast of North America. By holding Honolulu, Russia can . . . control the entire Pacific." But the tsar felt his navy was not strong enough to hold Hawaii against Americans and British. He turned down the offer.


You can hear the future tick
in the last silent seconds
of a Rocketdyne countdown

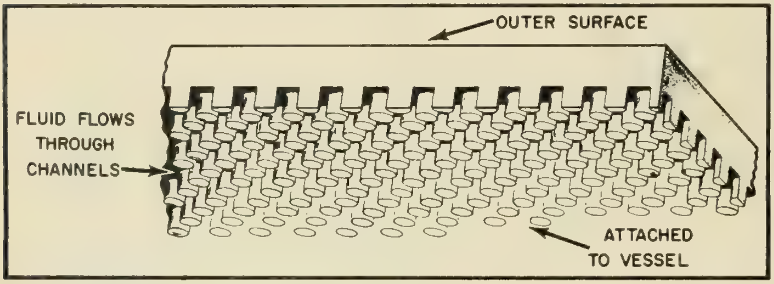
Turbulence Drag Drastically Reduced

Missile, aircraft, torpedo and submarine speeds may be advanced through 'porpoise-like' effect created by thin rubber skin on outer surfaces

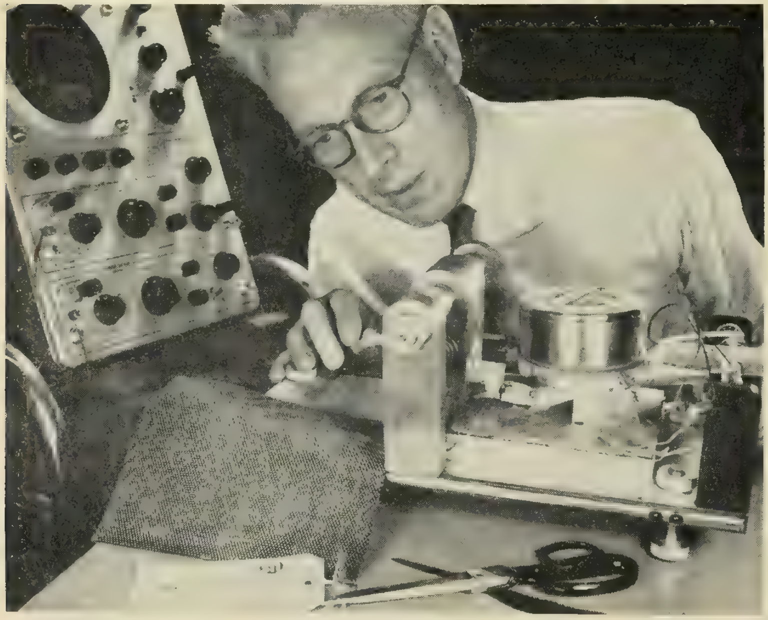
by John F. Judge

NEW YORK—First indications of a solution to the problem of propelling bodies rapidly through water have been revealed by Dr. Max O. Kramer, Vice President of Coleman-Kramer, Inc., Los Angeles.

Dr. Kramer's invention attacks the question by significantly reducing the drag effect due to the turbulence caused by the passage of an object through water. Underwater vessels actually use 70 to 90% of their propulsive energy to overcome this drag.



HOW RUBBER coating is attached to vehicle surface.



ABSORPTION OF energy in coating is measured by a U.S. Rubber research scientist investigating drag reduction in submarines.

Maximum speed in water or air is usually achieved by vehicle smoothness and shape. The new factor is the elimination of flow turbulence through the damping properties of a special coating.

The coating consists of a thin outer skin of rubber supported by a multitude of tiny rubber "pillars" attached to the surface of the vehicle. A free flowing viscous liquid is contained in the pillar area.

As the object moves through water, small disturbances next to the skin create an unstable boundary layer flow which in turn is responsible for the drag effect. When the outer skin is that of the Kramer device, it actually draws energy from the liquid flow, converts some of it to heat which is dissipated and thereby exerts a stabilizing influence on the passing water reducing the drag. Dr. Kramer says that, apparently, a significant effect is produced even if the energy removal is small.

The reason for the presence of the fluid, usually silicone oil, is primarily as a shock absorber—similar to the principle involved in the familiar automobile part. The Navy is keeping an eye on development of the system.

The scientist, a leading authority in the field of antiturbulence, explains that this is but scratching the surface. A great deal of testing and evaluation remains to be done, in both materials and theory. Theoretically, the drag can be reduced to a tenth of its present effect. Current experiments have been able to reduce the effect by 50% on underwater measuring devices.

• **Dolphins studied**—The coating, officially termed "boundary layer stabilization by distributed damping," is the result of many years of work. The last link was supplied by an examination of the skin of a porpoise. Biologists have pointed out that the tremendous

speed of this fish could not be due to any muscular or internal source but rather to some boundary flow effect. Engineers have denied this.

Dr. Kramer's investigation of the skin supported the biologists' view and supplied him with the concept of the smooth outer surface. The incorporation of this element into the system led to the finalization of the damping coat after many compounds and designs were tried. Realizing that rubber would play a large part in the development of his invention, Dr. Kramer joined forces with the scientists of U.S. Rubber's Research Center at Wayne, N.J. early in 1957.

Although the greatest potential of Lamiflo, the trademark name for the coating, lies in underwater use, U.S. Rubber expects to market it commercially for surface pleasure craft.

The inventor, who designed the German remote controlled dive bomber, Fritz 10—two of which sank the Italian flagship "Roma" in twenty minutes in 1943, explained that the configuration of the coated vehicle is extremely important. A World War II torpedo would not gain any advantage from Lamiflo because of its shape—blunt nose, long, straight cylindrical body and short, sharply tapering tail.

The ideal configuration is basically that of a fish—long a familiar shape in the air age. If applied to underwater missiles considerations of cleanliness and delicacy would be necessarily added to the problems of handling. And the application would vary from case to case since the coating would have to be designed to fit the particular factors present. Dr. Kramer feels that a drastic change in design would have to be made to take full advantage of his work. Submarine speeds up to 70 mph with current power plants would be possible with the development of a successful "skin."

Research is continuing in all areas, including possible application to rockets and planes in flight and to liquids flowing through pipes.

STREAMLINED TEST device is placed in water. Coating developed by U.S. Rubber has brought about 50% reduction in drag underwater.

UN Meeting on Space Sciences Seen

COSPAR may assist in its organization.

Four hundred attend Nice meeting with U.S. scientists presenting bulk of technical papers

by Anthony Vandyk

NICE, FRANCE—A United Nations meeting on space science may be organized next fall or winter with the assistance of COSPAR, the Committee on Space Research established by the International Council of Scientific Unions. The prospect of such a meeting was the main subject of informal discussion among delegates to the COSPAR-organized First International Space Science Symposium here. Some 400 delegates from all of the world's astronautically active countries participated in the five-day symposium.

Prior to the symposium the following members of the COSPAR bureau were elected:

H. C. van de Hulst, Netherlands, representing the International Astronomical Union, president; A. Blagonravov, Soviet Union, representing the Academy of Sciences of the Soviet Union, vice-president; R. W. Porter, U.S., representing U.S. National Academy of Sciences, vice-president; and E. Bucara, Czechoslovakia, representing Czechoslovakian Academy of Sciences; H. Massey, United Kingdom, representing Royal Society; M. Roy, France, representing the International Union of Theoretical and Applied Mechanics; W. Zonn, Poland, representing Polish Academy of Sciences.

Nations whose national scientific institutions are now represented in COSPAR include: Argentina, Australia, Belgium, Canada, Czechoslovakia, France, West Germany, Italy, India, Japan, Netherlands, Norway, Poland, South Africa, United Kingdom, United States, Union of Soviet Socialist Republics and Nationalist China.

While the largest national group was comprised U.S. scientists and the majority of important papers were delivered by Americans, participation by other nations was considerable. The presence of Russia's Professor Blagonravov succeeded in getting world press publicity for the meeting which would otherwise not have been achieved. Most of the delegates were from universities and government research establishments. Only a handful of industry representatives were on hand.

The majority of the papers were of a purely scientific nature and the sessions were devoid of the thinly-veiled company propaganda which scientific papers at some meetings represent. The physical arrangements for making available reprints and abstracts to delegates were good. In the meeting halls some delegates were in-

convenienced by the lack of translation facilities, but nearly all knew sufficient English to obtain clarification on points they had not understood.

These papers were read to the symposium: "Pictures of the Earth from High Altitudes and Their Meteorological Significance," H. Wexler; "Recent Extensions to Meteorological Measurements to Rocket Altitudes," L. M. Jones; "Density and Heat Conduction in the Thermosphere," M. Nicolet; "Method for Determining the Change in Satellite Orbits Due to Air Drag," D. G. King-Hele.

"Results of IGY Atmospheric Density Measurements above Fort Churchill," H. E. LaGow, R. Horowitz and J. Ainsworth; "Temperature and Winds in the Mesosphere Over the Arctic and Equatorial Regions," J. W. Townsend and E. B. Meadows; "Polarimetric Measurements of the Zenith Brightness from High Altitudes," A. Hata and K. Saito.

"Wind and Temperature Results Obtained in *Skylark* Experiments," G. V. Groves; "Measurements and Control of Rocket Attitudes," J. J. Gait; "Winds and Diffusion Rates in the Atmosphere from 80 to 230 km," by E. R. Manring; "Essai de determination de la temperature de la haute atmosphere," J. Blamont; "Measurement on OH and Na in the Upper Atmosphere," R. F. Chinnick; "L'etude spectroscopique du sodium projete dans la haute atmosphere a l'aide de fusees," A. Vassy; "Sodium Seeding by Rockets," J. A. Rees; "Utilisation d'un missile experimenta pour l'evaluation des concentrations en aerosols radioactifs artificiels en haute altitude," M. Labeyrie and M. Le Boiteux.

"Deviations angulaires theoriques dues a l'ionosphere pour des frequences de 20, 40, 108 MHz," H. Carru, R. Gendrin and M. Reyssat; "Determination of Electron Content by the Observation of Faraday Fading," W. T. Blackband; "Results from the First Combined Retarding Potential Analysis of Photo Electrons and Environmental Charged Particles Up to 234 km," H. Hinteregger; "Some Effects of the Ionosphere on Signals from Earth Satellites," W. C. Bain and E. Golton; "Two High Altitude Rocket Experiments," J. H. Chapman; "Ionospheric Electron Content Distribution Determined from Satellite Observations," O. K. Garriot; "A Determination of the Physical Properties of the Ionosphere Through the Phenomena of the Self-Demodulation of Radio Waves," M. Cutolo.

"The Use of Polarization Fading of Satellite Signals to Study the Electron Content and Irregularities in the Ionosphere," R. S. Lawrence and C. G. Little; "Ionospheric Measurements Using Environmental Sampling Techniques," R. E. Bourdeau, J. E. Jackson, J. A. Kane and G. P. Serbu; "Probe Method for the Measurement of Ion Density of the Ionosphere," T. Ichimiya, K. Takayama and T. Aono; "Ionospheric Positive Ions," C. Y. Jonhson and J. Holmes; "Enhanced Ionization in the Polar Ionosphere and Solar Corpuscular Emissions," T. Obayashi and Y. Hakura; "Some Properties of Shock Phenomena in Magnetofluid Dynamics," L. Napolitano.

"Origin and Nature of the Geomagnetically Trapped Radiation," J. A. van Allen; "Geophysical Evidence Bearing on Orbital Variation of Satellites and on the Radiation Belts," J. Bartels; "Physical State of Outer Atmosphere and Origin of Radiation Belts," T. Obayshi; "Physical Properties in the Outer van Allen Belt and Their Relation to the Phenomena in the Exosphere," Y. Inoue; "Electric Field Modulation of Cosmic Rays," A. Ehmert; "Some Problems of Geomagnetically Trapped Radiation," F. S. Singer.

"The Ultraviolet Spectrum of the Sun," R. Tousey, J. D. Purcell and D. M. Packer; "Profile of Solar Lyman-Alpha," R. Tousey and J. D. Purcell; "Photographing the Sun in Lyman-Alpha," J. D. Purcell, D. M. Packer and R. Tousey; "Ultraviolet Radiation in the Night Sky," T. A. Chubb and E. T. Byram; X-ray Radiation of the Sun," C. de Jeger; X-ray Emission Accompany Solar Flares," H. Friedman, T. A. Chubb and R. W. Kreplin; "Telemetering Monochrometer Measurements of Solar 304A Radiation and its Attenuation in the Upper Atmosphere," L Heroux, H. Hinteregger, K. R. Gamon and L. A. Hall; "Solar UV Spectroscopy and Applications to Problems of the Upper Atmosphere and the Solar Corona," W. A. Rense; "Correlation Between Fluctuations of Cosmic Radiation and Satellite Drag Data," E. G. Houtermans; "Certains aspects de l'activite solaries lies a la production derayons cosmiques par le soleil," J. F. Denisse; "Direct Measurements of Particle Fluxes in and Near Auroras," L. H. Meredith, L. R. Davis and O. E. Berg; "Direct Measurement of Protons and Electrons in Visible Aurorae," C. E. McIlwain; "Solar Flares with Type IV Radioburst and Transient Phenomena of Cosmic Rays," A. M. Conforto; "The Telluric Hydrogen Corona and Some of Its Consequences," F. S. Johnson; "The Solar Wind," J. A. Herring and A. L. Licht.

"Lines of Evidence Regarding the Composition of the Moon," H. Urey; "Some Current Problems of Lunar Topography," Z. Kopal; "Exobiology—a New Experimental Science," J. Lederberg; "Discussion Remarks on Contamination of Planets," M. Florkin; "Resultats d'observations indiquant la vie sur la planete Mars," A. Dollfus; "An Infra-red Mars Probe Experiment for Gathering Evidence of Extra-Terrestrial Life," R. W. Davies and M. Gumpel; "Extra-Terrestrial Life—Some Organic Constituents of Meteorites and Their Significance for Possible Extra-Terrestrial Biological Evolution," M. Calvin and S. K. Vaughn; "Experimental Problems in Space Biology," O. H. Schmitt.

"Micrometeorites," G. Best; Recent Direct Measurements of Cosmic Dust in the Vicinity of the Earth Using Satellites," H. E. La Gow and W. M. Alexander; "IGY Micro-Meteorite Measurements," M. Dubin; "The Density and Mass Distribution of Meteoritic Bodies in the Neighborhood of the Earth's Orbit," H. S. Brown; "Intensity of Cosmic Radiation in Space at Present and in the Past from Isotopic Data from Meteorites," J. Geiss and H. Oeschger; "The Origin of Tektites," J. A. O'Keefe.

"Upper Atmosphere Wind Measurement in the Antarctic," W. G. Elford and E. L. Murray; "Upper Atmosphere Structure Parameters According to Investigation Data Obtained on Rockets and Satellites in the USSR during IGY," S. M. Poloskov; "Calcul de la vitesse d'un engin ballistique en fin de course active," R. Genty; "Cosmic Ray Measurements in Australia," J. J. Quenby; "Cosmic Rays and Interplanetary Magnetic Field," J. J. Quenby; "Terrestrial Corpuscular Radiation and Cosmic Rays," S. N. Vernov and A. E. Chudakov; "Radiation Measurements during the Flight of the Second Soviet Space Rocket," S. N. Vernov, A. E. Chudakov, P. V. Vakneov, Y. I. Logachev and A. G. Mikolayev; "Cosmic Ray Investigation by the Second Cosmic Rocket Landed on the Moon," L. V. Kurnosova, V. I. Logachev, L. A. Rasorenov and M. I. Fradkin; "Measuring the Magnetic Fields of the Earth and Moon by Means of *Sputnik III* and Space Rockets I and II," S. S. Dolginov, E. G. Eroshenko, L. N. Zhuzgov, N. V. Pushkov and L. O. Tyurmina; "Photographs of the Reverse Side of the Moon," by A. A. Blaganravov; "On Corpuscular Radiation of the Outer Atmosphere," V. I. Krassovsky; "X-ray Measurements at 40 km Height in the Auroral Zone," K. Anderson; "Cosmic Rays Emitted by the Sun," A. N. Charakhchiab, V. F. Tulinov, and T. N. Charakhchian; "Results of Research of Meteoric Dust with the Help of *Sputnik III* and Cosmic Rockets," M. Nazarova.

7600-lb. More Payload Possible With Big Solid

A solid propellant-boosted three stage vehicle weighing one million pounds can place 7,600 more pounds of payload into a 300 mile orbit than a comparable liquid vehicle.

Giulio C. Panelli of Lockheed Aircraft Corp. told the annual meeting of the Institute of Aeronautical Sciences in New York that the solid vehicle can be built at the present time with no further advances in technology.

The scientist offered several practical vehicle designs but said that further economic and logistic analysis is required for a specific choice.

In another session of the space oriented meeting, W. H. Bostick announced the construction of the world's smallest electric rocket motor.

The high speed-pulsed plasma motor has an efficiency of 41%, an average speed of about 6 miles per second and is practical enough to be used in the altitude and position correction of satellites.

The scientist from Stevens Institute of Technology said the propellant speed of the motor can be adusted to higher values when the necessity demands.

The motor has an instantaneous thrust of 130 lbs. and with 100 pulses per second it will produce an average thrust of 0.04 lbs. This would give a 400 lb. satellite an acceleration of 0.0001 G's.

Bostick explained that this advance placed plasma propulsion in a better competitive position, with the ion rocket than was previously believed.

Project *Mercury* was the subject of a single evening session under Chairman Abe Silverstein, NASA Space Flight Development Director.

NASA scientists explained the workings of the capsule, reported on the *Mercury* research and development program and reviewed the operational plans for the orbital mission.

John F. Clark of NASA, in a session devoted to satellites, said that future experiments will emphasize earth-sun relationships in atmospheric, ionospheric, and energetic particle physics.

The role of the satellite in space was thoroughly explored by Fred L. Wipple of Harvard University.

Other papers included a study on the feasibility of thermally protecting cryogenic propellants on round trips to Mars and Venus. Arrangements of vehicle components, multiple reflective foils and insulation, and vehicle orientation were some of the methods suggested by G. R. Smolak and R. H. Knoll of NASA.

The problems and motivations involved in a manned lunar mission were explained by D. E. Serrill and H. J. McClellan of the Boeing Airplane Company. The propulsion requirements stressed were large, high energy boosters, throttleable landing engines and high reliability. The scientists pointed out that a good start has already been made in each of these fields.

Rear Adm. Paul D. Stroop, chief of the newly organized Bureau of Naval Weapons, spoke on the functioning of that organization. He told his luncheon audience that there were to be no drastic changes in the new bureau but there would be an emphasis on improved coordination. The bureau chief said that there would also be an increased level of effort at the various naval ordnance laboratories.

President Backs New 'Gap' Estimate

by William E. Howard

New U.S. intelligence evaluations minimizing the Soviet missile threat have spun Washington into a major political battle.

President Eisenhower lunged into the controversy in support of the new estimates of Russian strength—based suddenly on "intentions" as well as capability—only to be met by a stinging backhand from congressional Democrats.

Sen. Stuart Symington (D-Mo.) charged the Administration had deliberately "juggled" the estimates to help balance the FY 1961 budget. Symington and Sen. Richard B. Russell (D-Ga.), Chairman of the Senate Armed Services Committee, both declared that despite what the Administration said, a Missile Gap still exists.

Contending that Russia now holds a greater than 3 to 1 lead over the U.S. in missiles of all types, Symington said that "the Administration is apparently going to permit this gap to increase." He said this is true "even when one uses the smaller Soviet figures derived from their intent instead of capability."

Conceding that the dispute had political overtones, Russell said "it will be discussed in the campaigns and the people will decide. I hope no one will deal with it in terms of political gain."

The President entered the fight at his news conference Jan. 26, contending that there had been "misinterpretation" of the statement on the new intelligence appraisal given to Congress by Defense Secretary Gates—the statement which touched off the running debate.

The President did not mention the 3 to 1 estimate of Soviet missile superiority given by defense officials last year. Nor did he say if a Missile Gap exists today. Instead, he recalled that "subsequent intelligence" had shown that an "outcry" over an "alleged" Soviet bomber superiority three or four years ago had been wrong. He noted that the dispute resulted in Congress' adding $900 million to his budget for bomber appropriations.

• **Boiled-down position**—Although far from clear, Administration assessment of Soviet strength last week appeared to boil down to this: Any number of Soviet IRBM's and ICBM's by 1962 will be offset by the overall deterrent power of U.S. bombers and missiles.

Allen W. Dulles, Central Intelligence Director, told the Institute of Aeronautical Sciences in New York that the Russians are trying to exploit their missile and space successes with propaganda to make "the unsophisticated" believe they have an overall military superiority. He said such superiority "does not exist."

Claiming that CIA agents know a great deal more about Kremlin military plans than is made public, Dulles said his agency has not downgraded its estimate of Soviet missile capabilities. But he said it was wrong to let Russian leaders talk the world into believing ICBM's are the only weapons that count.

Answering criticism, directed at Gates, that the U.S. was now guessing Russian intentions, Dulles said his agency tries to determine how the Soviets intend to use a weapon once they have developed it. He added that the fact that "in later years of development we can crank into our estimates more of the elements of programming and future intentions than we can at the beginning, does not indicate any change in the intelligence approach to the problem."

At one point it appeared the battle would center over Senate confirmation of Gates, who had been serving under a recess appointment since the resignation of Neil McElroy as Defense Secretary. However, opposition to his appointment was suddenly withdrawn the same day as the President's news conference and the Senate confirmed him without debate or reference to the dispute.

NASA Contracting Methods Are Criticized

• **Does** NASA tell Congress and the U.S. General Accounting Office enough about its contract negotiations so that a proper review can be made?

This controversy raged before the House Space Committee last week.

Touching it off was NASA's recent refusal to give the Committee and GAO certain documents relating to negotiations which resulted in award of the *Nova* engine contract to Rocketdyne and the *Mercury* capsule contract to McDonnell.

The controversy ended in a stalemate, with the Committee emphasizing that the space agency was required by law to submit such contract documents to GAO, and NASA maintaining that it does not have to give up the documents under the Constitutional Authority of executive privilege—and that the Committee and GAO don't need this information anyway.

Both the Committee and GAO emphasized that they had no reason to believe there were any improper actions either by NASA Administrator T. Keith Glennan or the companies involved, but that it was necessary for Congress and its accounting arm to have this information to do their jogs properly.

Principal charges made by the Committee and GAO were:

• NASA had refused to give them certain documents pertinent to selection of the Rocketdyne and McDonnell proposals—notably the reports of the Chairman of the Source Selection Board;

• Access to these documents is essential to proper review of these contracts, and GAO has legislative authority to demand them;

• NASA is inconsistent because the same type of information was forwarded to the Committee on the *Little Joe* booster contract.

NASA officials argued that:

• NASA doesn't have to give up these documents under the authority of executive privilege;

• GAO and Congress do not need the reports, since the Administrator makes the contract decision, and is willing to give in full detail his reasons for doing so;

• NASA doesn't release these documents because they are the personal judgment of NASA subordinates in preparing recommendations for the Administrator;

• If such information were released, it might make NASA employes tend to soften criticism and in general offer a more restrained opinion.

Major reason for the present deadlock is that there are no court decisions testing the effectiveness of GAO's legislative authority or NASA's Constitutional executive privilege.

Rep. B. F. Sisk (D-Calif.) told Glennan that before the Committee authorizes NASA's $802-million budget, "we are going to have to get this thing straightened out."

GE Tells of Cheap Plug Nozzle Engine

General Electric Co. this week reported its long-secret plug nozzle engine is particularly suited to quick, cheap development to many million pounds of thrust.

The company disclosed details of the radical engine desigend (mentioned in M/R almost a year ago), which completely does away with the conventional inverted-cone liquid rocket thrust chamber.

In the new design, propellants would be ignited in a ring of small, segmented chambers around the outside base of a large conical spike or plug. Unlike clustered rocket designs now under development, combustion cells would be designed specifically to be integrated into a single power package.

A large portion of the gas expansion would occur outside the thrust chambers, following the contour of the plug, GE said. Since these supersonic gases would be self-adjusting as surrounding air became increasingly rarified during rocket ascent, the configuration would be more efficient at lower altitude than a conventional clustered engine, such as *Saturn*. This is the basis for the GE claim that the plug nozzle is particularly suited to use as a booster.

Developing a plug nozzle engine takes less time and is much cheaper than a conventional single-chamber engine because the single segment can be developed at low cost and then meshed together. Testing can be done on the single sections. It is cheaper than a six-engine or eight-engine chamber if the plug has more than that number of openings.

GE also says the plug nozzle design should also make possible significant space and weight savings over a conventional cluster, which would increase payload capacity. This results from the use of tankage, pumps, gimbal controls and other supporting hardware jointly, rather than separate hardware for each chamber.

Louis Michelson, manager of GE's rocket engine section at Evendale, Ohio, said extensive company-funded investigation of the plug nozzle concept has been under way for some time. The concept is also being explored further under a $400,000 contract awarded last July by the National Aeronautics and Space Administration.

The engine can be adapted to a wide variety of rocket requirements with a "substantial reduction in long and costly development required to build new propulsion systems," Michelson said. On completion of hasic engine development, the design can be readily and inexpensively scaled to virtually unlimited multi-million-pound-thrust levels, he added.

So far in America's rocket programs, he noted, propulsion system designers have encountered combustion phenomena and other problems that have largely defied logical scaling from small to larger units of the same design. Thus all meaningful testing has been conducted with experimental units of final thrust size.

—more about the missile week—

• **Washington**—NASA Administrator T. Keith Glennan told Congress the space lag between the U.S. and Russia is "four to five years." Other points made before the House Space Committee included: *Saturn* will get more money in a supplemental budget, and the development of its booster will be speeded by one year; Project *Mercury's* manned orbital flight should take place in 1961; and the ill-fated *Atlas-Able* moon orbiting payload will be attempted again in April.

• **Washington**—President Eisenhower said this company had an "admirable" record in the exploration of space and Americans had no reason to bow their heads in shame.

This was countered by Sen. Symington. (D-Mo), who said the Russians were "three to five years" ahead in space and the margin promises "to get worse instead of better." He also called it "perfectly ridiculous to say, as President Eisenhower has said, that the conquest of space has no military significance."

• **Washington**—Gen. Thomas D. White, Air Force Chief of Staff, told Congress that in spite of the growing missile threat, "the Soviet Air Force is the USSR's most dangerous weapon." This was seconded by Air Force Secretary Dudley C. Sharp, who said "the prime threat to our security is Soviet ability to attack us by manned bombers now, aircraft and ballistic missiles in the near future, and aircraft, missiles and orbital vehicles in the more distant future."

• **Portland, Ore.**—Defense Secretary Gates revealed some missiles of the first combat *Atlas* squadron at Warren AFB, Cheyenne, Wyo., will become battle-ready in April. He said the *Titan* ICBM will be operational in the summer of 1961.

• **Cape Canaveral**—A malfunction in the first-stage engine a split-second after ignition washed out a third attempt to launch a *Titan* and fire its second stage. The missile was saved when the engines cut off automatically. The failure Jan. 27 came less than 12 hours after successful *Atlas* shots here and at Vandenberg AFB. A *Jupiter* IRBM was successfully tested Jan. 25 at the Cape.

• **Edwards AFB, Calif.**—With a fifth shot of a *Minuteman* mockup prototype from its underground launcher, the Air Force announced that the basic configuration of the silo had been determined. Thus, the way is open for preliminary design of *Minuteman* bases. The shot Jan. 27 sent the missile 2000 ft. into the air where it was arrested by a nylon tether.

• **Washington**—A scientific advisory committee of the Democratic Party called for high priority development of weapons that can knock hostile military satellites out of the heavens. The group also said thre should be an immediate re-orientation of the entire U.S. space program to emphasize projects of immediate military and scientific benefit.

• **Washington**—The U.S. and Britain have agreed to launch cooperatively from Wallops Island, Va., a *Scout* rocket containing a scientific satellite. The experiment next year will measure electron temperatures and concentration, the ion mass spectrum, electron density, solar radiation and primary cosmic rays.

missile business . . .

By WILLIAM E. HOWARD

Choose a subcontractor like a wife—carefully.

Get allowable costs written down in detail at the front end of a missile contract, not the back end. It can save you money.

Spares and repair parts are extremely critical. If you can't support your product in the field—you haven't got a product.

These blunt nuggets of advice were passed out by an industry expert on DOD procurement the other week to a group of businessmen—all concerned with furthering their own company interests by learning more about the highly complicated art of defense contracting. The occasion of this rather unusual gathering (for many of those present were actual or potential competitors) was the first working session of the newly-organized Government Contract Management Association of America Inc., 425 Park Ave., New York City.

GCMA is an interesting experiment based . . .
upon the principle that industry—and the nation—will be better off if the people in industry all understand the basic facts of life about the management and administration of government contracts. Far from being a swap-shop for trade secrets, GCMA is viewed by its founders as a unique method for unraveling the complexities wound around any DOD contract. For the problems are tackled through a "mutual interchange" of experience and knowledge.

Thirty-five companies are represented in this non-profit association. And William F. Hurley, advertising director of American Machine & Foundry's defense products group and public relations man for GCMA, says the idea is catching on. Numerous requests for permission to open chapters have come in from the West Coast, Midwest and the South, according to Hurley. GCMA now plans to assimilate these chapters on a charter basis.

The first GCMA "short course" offered in . . .
a two-day seminar probed in depth into government procurement regulations, selection of sources, preparation of bids, analysis of bids, vendor proposals, methods and objectives of negotiation, definitization of contracts and approvals, budget control and financial monitoring and monitoring the contract. Future seminars will go into contract termination, pricing of contracts, negotiation techniques.

True to company predictions last year . . .
Douglas Aircraft Co. wound up FY 1959 on Nov. 30 with a loss. The amount: $33.8 million. This compares to a net profit of $16.8 million for the previous year. Sales of $863.8 million were also down from the $1.2 billion of a year ago. The company attributes the loss to charge-offs of $87.8 million in its DC-8 program. On the cheerier side, Douglas expects sales this year to climb over $1 billion.

Bendix Aviation Corp. is upgrading its *Talos* . . .
manufacturing facility at Mishawaka, Ind., to divisional status in step with "its greatly expanded activities and growing importance in the corporate structure." Formerly the facility was operated as part of the Bendix Products Division at South Bend. At the same time, the company named Arthur C. Omberg, Mishawaka general manager, assistant group executive to supervise the new division and Bendix's Hamilton, Ohio, division.

Also creating a new division is ACF Industries . . .
The company has merged its Avion and Nuclear Products-Erco Divisions into a new ACF Electronics Division. The move is expected to strengthen the company in the missile electronic field.

Latest U.S. firm to make a tie-up abroad . . .
is Magnavox, with the purchase of controlling interest in the Collaro Co.—an electronics manufacturer—from Great Universal Stores Ltd. The move is preparatory to organizing a British subsidiary, to be called Magnavox Electronics, Ltd., for development and sale of the company's products throughout Europe.

—letters—

No Problem

To the Editor:

My company, Major Tool & Machine, has subscribed to your book for some time and we are much impressed with the coverage you display on the Missiles and Rockets industry.

With this in mind, I thought I would contact you inquiring as to whether you have available a chart or information indicating Missile and Rocket prime contractors and that also might include the major subcontractors for each prime.

Jack Briere
Director of Sales
Major Tool & Machine, Inc.
1717 North Cornell Ave.
Indianapolis, Ind.

A copy of our Astrolog is in the mail.—Ed.

Microwave Hazards

To the Editor:

In reference to "Microwave 'Hazards' are Exaggerated" (M/R Dec. 14) you are right that Microwave hazards have been exaggerated in some news reports, but the material included in your article under the heading of Research at Participating Universities is evidence enough to make thoughtful people cautious.

The results of the investigation by Dr. Deichmann at Miami at 24,000 mc (1.25 cm wavelength) requires a re-evaluation of the conclusion that frequencies above 3000 mc. cause surface heating only. As Dr. Ely said while addressing the 12th Annual Conference on Electrical Techniques in Medicine and Biology, Nov. 11, 1959, "These effects are not as simple as these curves indicate. It gets me, those rats died."

Dr. Deichmann reported that post mortems revealed the same types of damage to the internal organs and veins of all the rats.

To me, this indicates a need to investigate further, considering the fact that although blood in a vein may be a poor dielectric waveguide by communication standards, it still may be a waveguide capable of delivering a lethal does of r.f. energy to an internal organ before it fails.

Many have drawn the conclusion that heating is the only effect of microwaves, but I predict that the acceptance of this conclusion will decrease. Dr. Carpenter's work at Tufts is strong evidence that there are non-thermal effects and that they appear to be cumulative. Further evidence may be expected because more investigators are considering such effects as probable and will be more likely to recognize them when they occur.

I will appreciate it if you will point out to the "many who feel that sufficient money has been spent in research" that results are just beginning to be reported from work done at a few spot frequencies and there is evidence that frequency may be an important variable, also. In addi-

tion, the biological work using pulsed sources has just started. It should be considered that therapeutic as well as harmful effects may be discovered if research is encouraged.

It will be found that even the measuring of r.f. field strength at the exposure level is not as simple as many have assumed. Our experience indicated that there is significant room for development work on the basic design of r.f. field strength indicators, particularly in applications where the whole equipment is subjected to the r.f. field or otherwise placed under severe overloads.

As one works on instruments to measure their fields, he gets a healthy respect for them.

Harry R. Meahl
High Frequency Measurements Engineer
General Engineering Laboratory
General Electric Company
Schenectady 5, N.Y.

Missiles and Morale

To the Editor:

The countdown proceeds—Ten, Nine, Eight . . . *Zero.* Zero is the crucial moment; a few moments later it is even a more crucial moment.

To begin with, if a million dollars worth of rocketry even lifts off the launch pad there is some jubilation among the scientists, engineers and technicians who willingly sweated through long and tedious hours to perfect the launching. I speak of R&D programs, of course, because after the missile package is perfected to the point of being operational the tension is relieved. Previous successful tests will naturally tend to build such confidence among missile men.

And how does human morale enter into the picture? As an individual . . . among those who have lost track of how many hours make up a day, who find that food is something you obtain from a "Roach Coach," that reading material is something contained in a test procedure, and that a wife and children are something very dear—at home, which seems to be in another world—may I say that the morale of the test crew is the key to any successful test . . .

How many of us have seen a top test team wrecked only because someone of the administrative type made some screwball changes without knowing the facts. It takes an expert psychologist . . . with some good knowledge of the missile business . . . to run the show. Politics have to go out the window in choosing personnel for testing and firing a missile. Missile men absolutely hate politics for cramping their work . . . they were chosen for their particular job because of their knowledge . . . to have to stand by and see their efforts wrecked and a good team scattered to the winds at the whim of some half-cracked ambitious individual is the end itself . . .

Elmer J. Gabel
Resident Engineer
Martin Co., Vandenberg AFB
Assoc. Mem. AIEE

contracts

NASA

$29,701—**The R. Hansen Co.**, Cleveland, for alterations to the altitude wind tunnel test rig area at Lewis Research Center.

MISCELLANEOUS

Cross-Malaker Laboratories, Inc., Mountainside, N.J., for development of classified equipment for advanced missiles. Amount not disclosed.

Texas Instruments, Inc., Dallas, for development and production of 24 telemetry systems for the *Centaur*. (Two contracts, amount not disclosed.) Subcontracts from **Convair Astronautics.**

$741,000—**Servomechanisms, Inc.**, Hawthorne, Calif., for production of air data computer test sets. Subcontract from **Hughes Aircraft Co.**

NAVY

$4,500,000—**Texas Instruments, Inc.**, Hawthorne, Calif., for production of the apparatus division of an advanced antisubmarine warfare system.

$121,167—**Bogue Electric Mfg. Co.**, Paterson, N.J., for power supplies, metallic rectifiers input and output with different volts, phases, cycles and watts.

$102,422—**Transdyne Corp.**, Albertson, N.Y., for maintenance of training aid systems.

$77,000—**Hermes Electronics Co.**, Cambridge, Mass., for design and manufacture of two systems, consisting of comb sets of crystal filters for the *Eagle*. Subcontract from **Sanders Associates**, Nashua, N.H.

$69,954—**Farrand Optical Co., Inc.**, New York City, for investigation, head set control of wide angle television presentation.

$68,100—**Integron, Inc.**, Waltham, Mass., for speed resolver computer production.

$39,631—**Operations Research, Inc.**, Silver Spring, Md., for psychological study of space flight training, biomechanics of space flight.

AIR FORCE

Aerojet-General Corp., Azusa, Calif., received a multi-million-dollar contract for production of the second-stage propulsion unit for the *Minuteman*. **Thiokol Chemical Corp.** was retained as technical backup.

Texas Instruments, Inc., Dallas, for the production of 37 telemetry systems for the *Bomarc C-2*. Amount not disclosed. Subcontract from **Boeing Airplane Co.**

$3,000,000—**CompuDyne Corp.**, Hatboro, Pa., for operational propellant-loading systems and an alarm system equipment at four *Titan* bases.

$1,042,200—**Electronic Communications, Inc.**, St. Petersburg, for transmitter equipment.

$351,516—**Purolator Products, Inc.**, New York City, for filter element assemblies and replacements.

$274,999—**Goodyear Aircraft Corp.**, Akron, Ohio, for repair and maintenance of *Mace* map synthesis equipment.

$250,000—**Waste King Corp.**, Technical Products Div., Los Angeles, for manufacture of air data probes.

$33,000—**University of California**, Berkeley, for research on "Chemical Kinetics at High Temperatures."

$32,530—**Yale University**, New Haven, Conn., for research on "Mechanical Properties of Intermetallic Compounds."

ARMY

$7,000,000—**Land-Air, Inc.**, Chicago, for engineering and instrumentation services at White Sands Missile Test Center.

$3,337,718—**The Martin Co.**, Orlando, for services and materials on the Missile Master system.

$500,000—**Sylvania Electric Products, Inc.**, Special Tube Div., Mountain View, Calif., for production of beacon magetron tubes for surveillance drones.

$390,000—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering and design services, ground support equipment, Saturn.

$192,910—**Western Electric Co., Inc.**, New York City, for *Nike* spare parts and components.

$161,000—**Sperry Utah Engineering Labs**, Salt Lake City, for repair parts for *Sergeant* system.

$134,559—**Douglas Aircraft Co., Inc.**, Santa Monica, for *Nike* replacement spare parts.

$121,590—**The Martin Co.**, Orlando, for replenishment spare parts and components for *Lacrosse* missile.

$120,000—**Chatham Electronics Div. of Tung-Sol Electric, Inc.**, Newark, N.J., for electron tubes.

$117,610—**Lockheed Missiles & Space Div.**, for basic studies of a new solar energy technique.

$109,942—**Gilfillan Bros., Inc.**, Los Angeles, for replenishment repair parts for *Corporal* missile.

$108,500—**North American Aviation, Inc.**, Canoga Park, Calif., for design and development of rocket engines. (Two contracts.)

$100,000—**Columbia University**, for analysis of radar noise in the *Nike* and related systems.

ASME-AIEE Meeting to Discuss Solar Space Power

Solar power for space vehicles will be the general subject for the Feb. 11 joint meeting of the American Society of Mechanical Engineers and American Institute of Electrical Engineers, in Washington, D.C.

T. F. Nagey, Allison Division Research Director for General Motors, will speak on solar mechanical-conversion power systems, and Niles F. Schuh will discuss solar static-conversion power systems. Schuh is Manager, Space Technology, Aircraft Equipment Department, Westinghouse Electric Corp.

The conference will be held at 8 p.m. in the Department of the Interior Auditorium. A joint ASME-AIEE dinner for members, guests and ladies is planned at the All States Dining Room, 514 19th St., N.W. at 6:30 p.m., preceding the meeting.

—when and where—

FEBRUARY

Chemical Institute of Canada, Toronto Section, Symposium on Gas Chromatography, Seaway Hotel, Toronto, Ont., Feb. 1.

Instrument Society of America, Houston Section, Instrument-Automation Conferences & Exhibit, Rice Hotel & Sam Houston Coliseum, Houston, Feb. 1-4.

Society of the Plastics Industry, Inc., Fifteenth Annual Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Feb. 2-4.

Sixth Annual Midwest Welding Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology; Chicago Section; American Welding Society, Illinois Tech Chemistry Bldg., Chicago, Feb. 3-4.

Institute of Radio Engineers, Professional Group on Military Electronics, 1960 Winter Convention on Military Electronics, Biltmore Hotel, Los Angeles, Feb. 3-5.

Institute of Radio Engineers, American Institute of Electrical Engineers, Seventh Annual Solid-State Circuits Conference, University of Pennsylvania, Philadelphia, Feb. 10-12.

Annual Meeting of American Institute of Mining, Metallurgical and Petroleum Engineers, Sheraton Atlantic Hotel and Statler Hilton Hotel, New York City, Feb. 14-19. **(Metallurgical Society Forum on Navy Materials Problems,** Feb. 15).

Third Annual Missile/Space Industry Conference, National Rocket Club, Sheraton Park Hotel, Wash., D.C., Feb. 16-17. **(Dr. Robert H. Goddard Memorial Dinner,** Feb. 17).

First National Symposium on Nondestructive Testing of Aircraft and Missile Components, sponsored by Southwest Section, Society for Nondestructive Testing; Southwest Research Institute, Hilton Hotel, San Antonio, Feb. 16-18.

AIEE Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia, Feb. 18-19.

National Society of Professional Engineers Winter Meeting, Broadview Hotel, Wichita, Kan., Feb. 18-20.

Engineering Materials and Design Exhibition, Industrial and Trade Fairs, Ltd., Earls Court, London, Feb. 22-26.

National Association of Corrosion Engineers, Tulsa Section, 11th Annual Short Course, Mayo Hotel, Tulsa, Feb. 24-26.

MARCH

Navy League Seapower Symposium, Sheraton Park Hotel, Washington, D.C., Mar. 1-3.

ASME Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, Mar. 6-9.

Heat Transfer Symposium, Mechanical Engineering Dept., University of Florida, Gainesville, Mar. 7-8.

Society for Aircraft Material and Process Engineers' Midwest Chapter Symposium, "Processing Materials for Reentry Structures," Miami Hotel, Dayton, Ohio, Mar. 9-10.

Mechanical Properties of Engineering Ceramics, sponsored by North Carolina State College School of Engineering, and Office of Ordnance Research, U.S. Army, N.C. State College Campus, Raleigh, N.C., Mar. 9-11.

Institute of the Aeronautical Sciences, National Flight Propulsion Meeting, (Classified), Cleveland, Mar. 10-11.

Electronic Industries Association, Defense Planning Seminar, Statler Hilton Hotel, Washington, D.C., Mar. 15.

Symposium on Optical Spectrometric Measurement of High Temperatures, sponsored by University of Chicago's Applied Science Laboratories, Jarrell-Ash Co., National Science Foundation, University of Chicago, Mar. 23-25.

American Power Conference, American Society of Mechanical Engineers, Sherman Hotel, Chicago, Mar. 29-31.

APRIL

Sixth Annual Advanced Statistical Quality Control Institute, University of Connecticut, Storrs, April 3-15.

1960 Nuclear Congress, "What Will the Future Development of Nuclear Energy Demand from Engineers?," sponsored by 28 engineering, scientific, management and technical organizations. Includes 6th Nuclear Engineering and Science Conference, 8th NICB Atomic Energy in Industry Conference, 6th International Atomic Exposition, New York Coliseum, New York City, April 4-7.

American Chemical Society, 137th National Meeting, Cleveland, April 5-14.

American Rocket Society, Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif., April 6-8.

Institute of Environmental Sciences, 1960 National Meeting, "Hyper-Environments—Space Frontier," Biltmore Hotel, Los Angeles, April 6-8.

ASME-SAM Management Engineering Conference, Statler-Hilton Hotel, New York City, April 7-8.

Symposium on Chemical Reactions in the Lower and Upper Atmosphere, sponsored by Stanford Research Institute, Mark Hopkins Hotel, San Francisco, April 18-20.

CLASSIFIED

Advertisers' Index

Doolittle's Formula To Win Cold War

Speaking before Silver Quill dinner guests in Washington recently, Lt. Gen. James H. Doolittle gave a summary of our situation vis-à-vis the Russians—and a formula for maintaining our world leadership. One of the major items he dwelt on was the space race. The attitude of this national hero, military airman, civilian flyer and businessman seemed, to listeners, considerably at odds with that of the Administration.

He listed six fundamental factors which, he felt, must be considered if we are to deal intelligently with the Soviets:

1. There is no sound indication that they have abandoned or even altered their basic objective of world Communism and world domination.

2. Our military might has to date deterred them from quickly achieving their objective by force of arms.

3. They will continue to endeavor to advance the cause of Communism by propaganda, infiltration, subversion and, if permitted, by limited warfare.

4. Over the long haul, economic warfare may well offer the best means of achieving their objective.

5. The present Soviet "peace offensive" must be considered in the light of their desire to reduce military expenditures, strengthen their economy and improve their present low standard of living.

6. "Peaceful coexistence," to the Soviets, means the eventual imposition of Communism by means other than all-out war.

He noted a "startling fact":

"The Soviet economy is, in effect, a space economy *now* while ours is largely a consumer economy. They are concentrating on the space race as much of their scientific, technological and economic resources as they think necessary to win it.

"I'm sure they don't expect to win converts to Communism on the moon or Mars. They are using their space 'firsts' in an effort to win converts here on earth—in the Middle East, Asia, Africa, Europe and the Americas.

"The Soviets measure the value of their space ventures, regardless of any other results, primarily in terms of waging and winning the cold war."

General Doolittle, presently head of Space Technology Laboratories, quoted Walter Lippmann: "The critical weakness of our society is that our people do not have great purposes which they are united to achieve . . . the public mood is defensive, to hold on and to conserve, not to push forward and create." Then he named five ingredients which he felt were essential to achievement of a national purpose:

1. An appreciation of moral values and a commitment to live in accordance with them.

2. Support for education, a revival of scientific learning.

3. Concentration on science and technology.

4. A sound and growing economy.

5. Dedication to national security.

The fifth, national security, he described as overriding. He added:

"The problems of national security take on new dimensions in the Space Age. For one thing, deterrent power that really deters has to exist in a state of split-second readiness. It has to be safeguarded against a surprise first strike with nuclear weapons.

"The importance for the race for space comes into sharper focus when we consider the need for perfected satellites for reconnaissance, communications and early warning systems."

He noted that we "allowed Stalin a nearly uncontested eight-year head start on rocket and missile development. We could lose *all* by allowing an adversary to gain technical advantage in space weapons."

We would like to see some of the James Doolittle feel of danger, appreciation of values, sense of urgency and some of his drive communicate itself to the public, which must take a great share of the blame for our national "lack of purpose." And to the Administration, which has failed both to direct and to lead.

Clarke Newlon

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

Business end of the Titan—by Avco—The nose cone for the Air Force's Titan—designed to withstand the scorching heat and incredible shock of atmospheric re-entry—is a product of Avco research. Now, with the successful flight of this ICBM, the Air Force has assigned two new and important projects to Avco: an advanced design nose cone for the Titan and the nose cone for the third generation of intercontinental missiles—the mighty, solid-fueled Minuteman.

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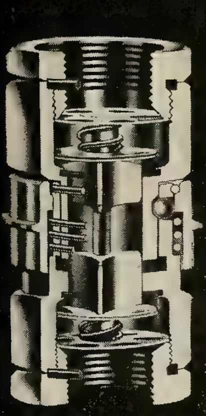

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Missiles and Rockets Volume 6 Number 6

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COVER: Booster top for the *Saturn* is assembled at NASA's Huntsville, Ala., facilities. For a report on how the vital program has finally picked up some momentum, see p. 14.

ALL-PLASTIC solid propellant rocket proposed by Norair. The company says its research indicates the project is feasible and plastics may be dominant high-temperature material. Story starts on p. 25.

ADVANCED *Agena* satellite vehicle is hoisted into place for test firing. Lockheed has admitted newsmen to its Santa Cruz, Calif., *Agena* facility for the first time, praises Bell engine. See p. 34.

AIR FORCE controllers at ARDC's Sunnyvale, Calif., satellite center are in contact with launch site, four tracking stations, Hawaii control center. See story on p. 36.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

30,400 copies this issue

FEBRUARY 8 HEADLINES

ASTRIONICS

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THE MISSILE WEEK

U.S. Reg. Pdg.

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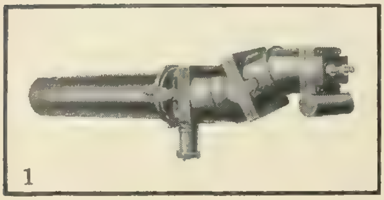
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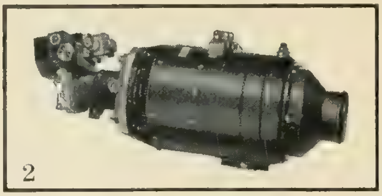
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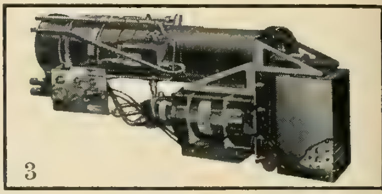
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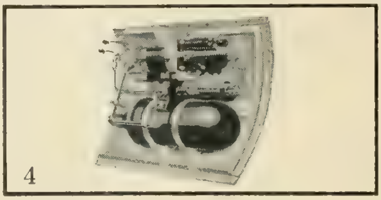
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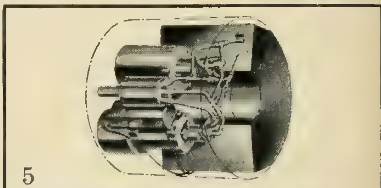
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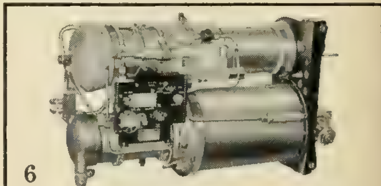
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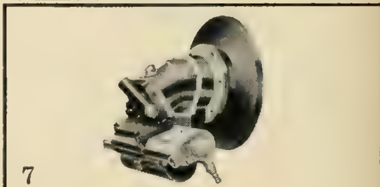
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Washington Countdown

IN THE PENTAGON

A new ABMA . . .
is scheduled to be built from key parts of the old when the agency and its $100-million complex of facilities is finally transferred to NASA. The Army is planning to use a cadre of ABMA personnel to rebuild the agency for development of its longer range missiles.

• • •

The last four *Polarises* . . .
launched from Cape Canaveral are understood to have impacted squarely in their designated target area. Accuracy of the Lockheed test vehicles on the 900-mile shots is being measured in yards instead of miles.

• • •

Two million pounds of thrust . . .
is the new specification being put on the proposed Air Force solid booster. The plans to pump money into the program are now on the desk of Dr. Joseph Charyk, Assistant Air Force Secretary for R&D, awaiting approval. (See this issue, pages 29-31)

• • •

The big Soviet rockets . . .
launched into the Pacific are estimated to have had about 1 million pounds of thrust. The big question posed by military experts is whether the Red rockets were single-chambered vehicles or were clustered.

• • •

***Titan* testing . . .**
at Cape Canaveral now is expected to be pushed at a rapid rate. Meantime, launching silos for the Martin ICBM at Lowry AFB, Colo., are reported to be one-fifth completed.

• • •

Fumes-in-the-wind note . . .
Vandenberg AFB is now referring to itself in press releases as the Vandenberg Aerospace Center.

ON CAPITOL HILL

Government reorganization . . .
in the missile/space field is rapidly snowballing into a major congressional and campaign issue. However, it remains doubtful whether anything beyond some slight tinkering with the present machinery will result.

Military role in space . . .
is considered the most likely to get attention from Congress. Democratic leaders are understood to be very concerned over statements by the administration that the military has little reason to go into space beyond a few thousand miles.

• • •

Military procurement . . .
will get a thorough going over beginning this week by the Senate Armed Services Subcommittee headed by Sen. Strom Thurmond (D-S.C.). The subcommittee has before it a series of bills calling for the drastic overhaul of present procurement practices.

AT NASA

An impact bag . . .
is the latest device to be added to the man-in-space *Mercury* capsule. After the heat shield separates from the capsule during re-entry, the perforated impact bag will billow out and cushion the landing.

• • •

Top possibility . . .
to succeed NASA Chief T. Keith Glennan when he retires at the end of 1960 is considered to be Assistant NASA Administrator Richard E. Horner. The 42-year-old former Air Force official is considered to be the mostly likely candidate for the job no matter who occupies the White House next January.

• • •

Solids Expert Elliott Mitchell . . .
has been named to head NASA's new propulsion staff. However, the agency's propulsion R&D will continue to be mainly in the field of big liquid engines for such projects as *Saturn* and *Nova.*

INTERNATIONAL

Japanese sale . . .
of $277,000 worth of *Kappa 6* research rockets to Yugoslavia is still to be made final. Representatives of YAA—the Yugoslav Astronomical Association—are understood to want to tour Japanese facilities first.

• • •

French antigravity research . . .
is being imported by the United States. Dr. M. J. Pages, the French antigravity expert and father of the "space submarine," is reported to have been hired by an unidentified U.S. firm.

letters

AAS on Technical Meetings

To the Editor:

I read with interest your recent article (M/R, Jan. 11, p. 14) on the cost of technical meetings. The American Astronautical Society, which is the only professional Society in the U.S. dedicated *solely* to the Astronautical Sciences, is well aware of this problem. However, it is sometimes very difficult to get coordinated schedules with all the Societies now getting into space. Our Society was holding comprehensive meetings on Astronautics as early as 1954.

It is interesting that the study showed a lack of overlapping, and I think the various Societies should be commended for their effort here.

The publication of material presented at these meetings is a severe problem for all Societies. However, the AAS has since 1957 published the Proceedings of their meetings, and in 1959 these Proceedings were produced in hard-back copies as *Advances in the Astronautical Sciences* by Plenum Press. It is now our policy to publish the Proceedings after each meeting. To my knowledge we are the only professional society dealing in the Space Sciences that offers this service to the technical community.

George R. Arthur
President
American Astronautical Society
516 Fifth Avenue
New York 36, N.Y.

Back to Mt. Tranquillon

To the Editor:

Everyone knows that the State of California is overwhelming with superlatives. This is the home of the largest horned toad in the world, as well as the world's biggest barrel hoop and the world's most superfluous freeway (between Sepulveda Boulevard and Sepulveda Boulevard).

However, in your Dec. 28 issue you have added a new superlative. As seen in the picture caption, lower right on page 17, your geographical researchers have discovered 21,500-foot Mt. Tranquillon in the wilds of Pt. Arguello. This mountain obviously qualifies as the highest yet discovered in the (contiguous) continental U.S., and is enough to make the State of Alaska look to its laurels.

As a tribute to the magnificent climate of California, one notes that, even at this altitude, there is no trace of snow or ice, and trucks may be easily driven to the summit on our wonderful all-weather roads.

Jackson W. Granholm
1516 El Dorado Drive
Thousand Oaks, Calif.

As a matter of fact, if it were 21,500 feet high Mt. Tranquillon would cast a shadow over Alaska's 20,300-foot Mt. McKinley—popularly thought of as the U.S.' highest. M/R has been similarly chidden before (Letters, Jan. 25, p. 56), will send this to the Wayward Comma Dept.—Ed.

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Industry Countdown

MANUFACTURING

Upgrading megaton wallop . . .

of *Atlas* apparently is behind Avco's entry into its nose cone program—primed by General Electric. An "advanced" Avco re-entry vehicle was aboard the Jan. 26 *Atlas* fired successfully from the Cape. A larger warhead already is being developed by Avco for the *Titan* ICBM and the Air Force could be trying a somewhat similar configuration for *Atlas*.

• • •

R&D costs for an ICBM . . .

are estimated now at 60% of the total cost of the weapon. Aerospace Industries Association also notes that this has caused a pronounced shift in the missile/aircraft industry personnel. A survey of 30 prime contractors shows that out of 451,000 employes in 1959, 65% were involved in engineering, tooling and other indirect specialties and only 35% were in direct manufacturing jobs. This, says AIA, is the highest ratio of indirect to direct workers of any major manufacturing industry.

• • •

Pressure is building up . . .

in Congress for a greater "spread" in defense contracts. Several key Democrats are concerned over DOD figures showing 73.8% of procurement dollars are concentrated in 100 firms. Other figures being cited show that large firms get about 97% of all defense R&D work.

• • •

Overland train . . .

idea for *Minuteman* ICBM is still being debated. The Army Transportation Corps has developed a cross-country diesel-powered train, but it's reported the Air Force is looking elsewhere for a mobile land system which would travel farther afield than its railroad launcher for *Minuteman* . . . General Motors, which is said to have come up with some cross-country designs, is now making the prototype transporters to carry *Minuteman* missiles on highways.

• • •

Douglas Aircraft is spending . . .

$4 million to consolidate all its missiles and space systems engineering work in one enlarged facility at Culver City, Calif.

PROPULSION

New *Redstone* engine . . .

feature allows troops in the field to vary propellant mixture ratio to suit the mission. The control was tried for the first time in a tactical launch Jan. 26 at White Sands with an A-7 engine.

ASTRIONICS

Companies deeply . . .

involved in thin-film R&D for integrated solid-state subsystems are disputing the belief that molecular electronics is the total answer for the future. Rather, they feel, advanced systems will incorporate the best of both approaches.

• • •

At least one . . .

guidance system contract has been killed and two more are in doubt as a result of an Army Signal Corps program assessing the feasibility of failure prediction prior to designing electronic inertial systems. Motorola has the contract. All three services are closely watching the results.

WE HEAR THAT—

Downrange "Bumblebee" . . .

radar for the Pacific Missile Range is almost ready. One of the contractors for the vastly improved system is RCA . . . Marquardt Corp. is ready to merchandise its know-how in the A&E field through a new Facilities Engineering Division . . . A new department serving the radar systems market has been set up by Texas Instruments . . . Expansion in the reinforced plastics field for missiles and space vehicles is under way at Horkey-Moore Associates . . . Advanced Intelligence Corp. is a brand new company being established at Rancho Sante Fe, Calif., for the calibration of large optical instruments . . . Surprise of the Week: Lockheed's acquisition of a 50% interest in Grand Central Rocket Co.

Von Braun Praises NASA Leadership

Expert says he's 'satisfied' with transfer and civilian agency's 'clear decisions' on Saturn, asks for—and is promised—more trained personnel

Dr. Wernher von Braun praised his new NASA bosses before the House Space Committee last week and found himself in sharp disagreement with his old boss, Maj. Gen. John B. Medaris. (See M/R, Feb. 1, 1960.)

The Huntsville rocket expert said he was "thoroughly satisfied" with his organization's transfer from the Army ABMA to NASA, and urged Congress to confirm the President's action as soon as possible.

Complimenting NASA for making "clear decisions" immediately upon taking over the *Saturn* booster program, Von Braun said "they got the President to approve almost all of the $100 million we needed."

He said that his team and the space agency also had quickly arrived at a "unanimous decision" on *Saturn's* upper stages.

Von Braun disagreed with Gen. Medaris' recent recommendation for a single military missile-space agency. He told the Committee that the civilian space program needed large boosters before the military space program, and therefore it was reasonable that NASA should develop *Saturn* and *Nova*.

He disagreed with Medaris that military space was being, or would be, downgraded, pointing out that the military could use *Saturn* after it was developed when they have a need for it.

In answer to a question as to whether he liked the present space set-up, Von Braun answered in the affirmative, but added "if enough money goes into it, any organization will do."

Von Braun declined offers from the Committee to add more money to *Saturn's* program this year, stating that he now had about all of the money he could profitably spend. When pressed further, he said that additional money could be spent, but that it probably would be wasted.

Two criticisms that Von Braun had of the present program were: (1) the additional money that NASA has procured for *Saturn* can't be spent until July and that some of it could be used earlier; and (2) he needs more trained personnel.

Rep. George P. Miller (D.-Calif.) told Von Braun that the Committee would move to see that the Huntsville team got 100 more executive positions.

Von Braun said under the accelerated program the first test vehicle would fly in FY '61, and three in FY '62. Ten vehicles will be fired before the first completely operational *Saturn* leaves the pad in the second quarter of 1964, Von Braun said.

The *Saturn* vehicle will have three different configurations, according to Von Braun. The first, C-1, will have a cluster of four 20,000 lb. liquid hydrogen engines as its second stage, and two of these engines as a third stage. This configuration, which will be operational after 10 firings in 1964, will be able to put from 23,000 lbs. to 25,000 lbs. in orbit.

The second configuration, C-2, will have four 200,000 lb. hydrogen engines as its second stage, and the two Pratt & Whitney configurations on top. Von Braun said this configuration would lift a 45,000 lb. payload, and could soft-land payloads on the moon and send two men on a figure-eight trip around the moon and back.

Von Braun said that all of the *Saturn* boosters will be recoverable and that they hope to use them over again.

The father of the *Explorer* program said that *Saturn* spending should reach a constant level in 1961 for two or three years. A proper evaluation of the *Saturn* system, he predicted, could be made in 1962, and that could determine how much money would be spent on the program after that.

The space agency plans to manufacture the clustered booster at the rate of six a year, but Von Braun said this could be accelerated to 20 a year "when and if we find we need them."

Von Braun said that the U.S. would not catch up with Russian space accomplishments until 1964, and that he thought the Soviets probably were working on much larger rocket engines than they are presently launching.

"It wouldn't surprise me at all," von Braun testified, "if the Russians make a soft lunar landing and put a man in space this year."

Though he felt that *Saturn* is now adequately funded, Von Braun told the Committee that more money could be spent for space research in other areas. "There is aways a danger of putting most of the money into weapons systems or space vehicles like *Saturn*, and not putting enough money" in (other important projects).

Titan Passes Ignition Test

The trouble-plagued *Titan* ICBM Feb. 2 had its first successful second-stage ignition, breathing new hope into a program which has been severely criticized from a management standpoint.

It was the fifth successful launch of the ICBM, but the first successful since May 4. In the interim, Air Force criticized Martin management of the program but pronounced the big bird technically sound.

The 41-foot second stage separated and the Aerojet-General 80,000-lb. thrust-engine ignited at an altitude of about 40 miles. Its 24 tons of weight made it the largest space-fired vehicle to date. Impact was about 2000 miles down range at a "preselected" target area.

The *Titan's* guidance system, designed by Bell Telephone, successfully performed its functions of relaying the missile's position to ground guidance control and receiving and decoding steering commands.

The radio inertial system used in this firing is slated to be replaced by an A. C. Spark Plug all-inertial system before becoming operational.

The first and second stage engines of the *Titan* are built by Aerojet, generating a total of 380,000 lbs. thrust with LOX and JP-6.

The complete vehicle launched was the same one that automatically cut itself off on the pad Jan. 28. There was no damage to the missile or the stand.

The perfect launching is expected to improve the overall program picture which suffered a severe blow in the explosion on the stand Dec. 12. This was

the climax of a series of delays and mishaps reaching back to May 4, date of the fourth successful firing.

The technical soundness of the missile has never really been doubted, even by its most vehement detractors, and the unqualified success of the latest shot supports this claim.

Air Force plans call for a total of 14 *Titan* squadrons, which, with 13 *Atlas* squadrons, will provide a maximum number of operational missiles during the critical five years immediately ahead.

The two-stage bird is slated to be "technically operational" in October, 1960. No information was released concerning the next *Titan* launching, but the complete guidance systems and nose cone separation tests have yet to be made.

The Martin Company will use the *Titan* as the basis for booster of the *Dyna-Soar* system. The Air Force awarded the booster portion of the manned glide-vehicle to Martin last November.

Record Crowd Due for Missile/Space Meet

Moderator for the Marketing Panel of the National Missile Space Conference in Washington will be Lt. Gen. Mark E. Bradley, Deputy Chief of Staff, Materiel Hq. USAF, conference officials have announced.

The panel will be held Wednesday afternoon, Feb. 17, at the Sheraton Park Hotel, conference headquarters.

Registrations for the two-day conference, Feb. 16 and 17, are considerably ahead of those of previous years, officials said, and total attendance is expected to be well above that of 1958 and 1959.

Other panels will be headed by Dr. Fred Singer, Professor of Physics, University of Maryland; Theodore F. Koop, CBS vice-president, and Kurt R. Stehling, Aeronautical Research Scientist, NASA. Panelists include:.

Sir Leslie Knox Monro, former Australian Ambassador to the U.N.; Dr. Homer Joe Stewart, NASA; Sen. Thomas Dodd, Conn.; Congressman James C. Fulton, Pennsylvania; Rear Admiral Thomas F. Connolly, Bureau of Naval Weapons; Andrew G. Haley, past president, International Astronautical Federation; Dr. Donald Michael, Brookings Institution; Clarke Newlon, MISSILES AND ROCKETS MAGAZINE; Dr. Dorothy Simon, Avco; Bernard Haldane, Fairleigh Dickinson University.

Dr. Leo Steg, General Electric Co.; Martin Decker, president, Decker Corp.; Dr. Vincent Cushing, Fairchild; Congressman Victor L. Anfuso, New York; Dr. I. M. Levitt, Franklin Institute; Norman L. Baker, Space Business Daily; and Brig. Gen. Donald D. Flickinger, USAF, ARDC.

Objective of the conference is to promote policies, programs and legislation necessary to establish and maintain United States leadership, and to stimulate civil and military space programs for the benefit of mankind.

The conference will culminate in the Goddard Memorial Dinner on Wednesday night and presentation of the Dr. Robert H. Goddard Memorial Trophy by MISSILES & ROCKETS MAGAZINE. Chief speaker for the dinner will be Lt. Gen. Bernard Schriever, Commander of the Air Research and Development Command.

Luncheon speakers Tuesday and Wednesday will be Krafft Ehricke, Convair, and Arthur Kantrowitz, Avco.

Among co-sponsors of the conference, with the National Rocket Club, are:

American Machine and Foundry Corp., Arthur D. Little, Inc., Avco Corp., Continental Aviation and Engineering Corp., Convair Division of General Dynamics, Cooper Development Co., Crucible Steel Corp., Decker Corp., Electric Auto Lite Co.

Fairchild Engine and Airplane Corp., Fisher Associates, Inc., General Electric Co. (Missile and Space Vehicle Dept.), Joy Manufacturing Co., C. B. Kaupp & Sons, Lockheed Corporation, Los Angeles International Air and Space Exposition, The Martin Co.

MISSILES & ROCKETS MAGAZINE, North American Aviation, Inc., Nortronics, Page Communications Engineers, Inc., Pan American World Airways, Inc. (Guided Missiles Range Div.), Perkin-Elmer Corp., Portland Cement Assoc., Space Technology Laboratories, Inc.

Washington Technological Associates, Inc., Western Gear Corp., Westinghouse Defense Products, Thiokol Chemical Corp., and Douglas Aircraft Co., Inc.

—news briefs—

• **Washington**—President Eisenhower accused military leaders critical of the U.S. missile/space posture of being too parochial. He said in his opinion the present programs were eminently capable of deterring a Russian attack. The President predicted that the relative positions of the two countries would be about the same three or four years from now as they are today.

• **Washington**—Despite the insistence of his civilian boss that he was "unrealistic," SAC Commander Gen. Thomas S. Power refused to back down from his warning that Russia could knock out U.S. retaliatory power with 300 missiles in 30 minutes. Power told Congress he stands behind "every statement" in a recent speech which Defense Secretary Gates called unrealistic. Power also said Congress should provide extra funds to keep the highest percentage possible of his bombers airborne at all times.

• **Moscow**—Russia wound up its Pacific missile testing Jan. 30 with a second shot into the same impact area as its Jan. 20 launchings. No range or miss distance was indicated for the second shot. A Soviet scientist, Prof. Georgi Duboshin, indicated that there would be more Pacific shots and that they were preliminary to interplanetary space probes.

• **Washington**—Administration defense critic Sen. Stuart Symington (D-Mo.) introduced legislation to abolish the secretaries of the Army, Navy and Air Force. He said his bill would set up a modern structure of unified or integrated commands under a single chief of staff. The Defense Secretary's powers would be strengthened and the secretaries for each service would be replaced by undersecretaries.

• **Huntsville**—On his retirement Jan. 31 as chief of the Army Ordnance Missile Command, Maj. Gen. John B. Medaris revealed he would become chairman of the board of Electronic Teaching Laboratories, Washington, D.C.

• **Asheville, N.C.**—Celanese has begun production at its Amcel Propulsion Inc. Division on a major order for the Air Force of a high explosive compound which could become a double-base solid rocket propellant. The company is starting a big drive to hire scientists and engineers for the Amcel facility.

More catch-up than speed-up . . .

Mighty *Saturn* Program Shifts into Middle Gear

New NASA request for $98 million in program brings total FY '61 authorization to $246 million; but program still not seen as all-out

by James Baar

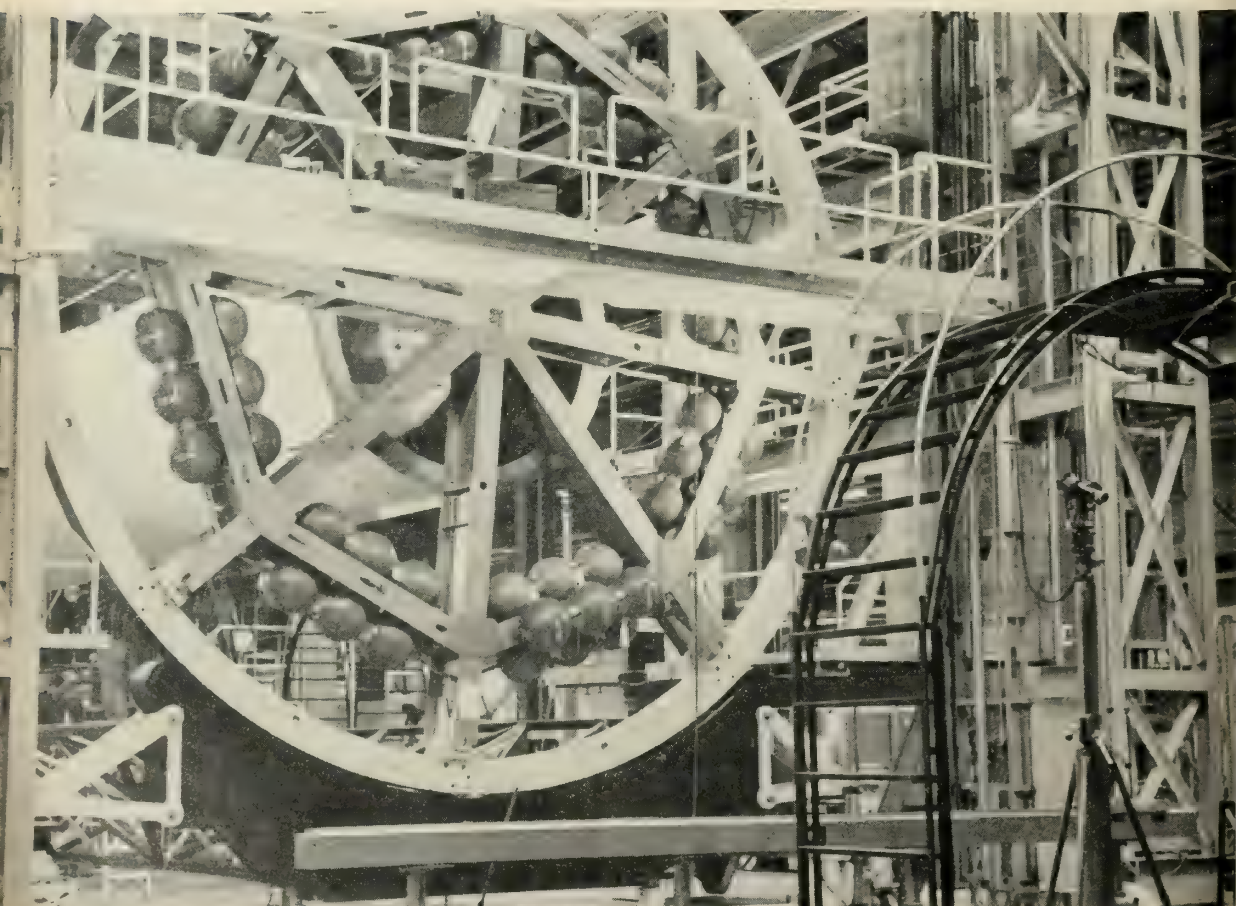
HUNTSVILLE, ALA.—The Administration's long-delayed burst of energy this week in advancing the mighty *Saturn* program appears more and more to involve mostly catch-up rather than speed-up.

The new NASA request submitted to Congress asking for an extra $98 million for *Saturn* in FY 1961 brought the total new money sought for the coming fiscal year to $246 million.

NASA officials said the total request would enable them to push forward a *Saturn* program aimed at:

- Launching the first operational *Saturn* of any kind in late 1962—an alleged one-year gain.
- Launching 27 *Saturn* vehicles between 1962 and the end of the decade.
- Building a second *Saturn* launching pad and a second static testing pad, providing the program with some back-up.

It was widely noted that the new figure of $246 million is only a shade below the maximum $250-million program for FY 1961 advocated months ago by Dr. Wernher von Braun, boss



BOOSTER TOP for *Saturn* takes shape as the first test model is assembled for static testing probably in late March.

of the *Saturn* program. And Von Braun told the House Space Committee this was about all he could "profitably" use in FY 1961.

Officials also stressed in Washington that Von Braun has been authorized to use overtime in the program for the first time. Meantime, at Huntsville and Washington, contractors received information on which to base bids for development of huge second and fourth liquid hydrogen stages for *Saturn*. And the first *Saturn* booster was assembled for the first static test probably in late March.

• **Altered aspect**—The overall appearance was that the *Saturn* program has been greatly accelerated. However, an analysis of the proposed funding offered an altered aspect:

• The one-year saving brings the first operational launching only to the approximate time when a launching would have taken place under the orginal ARPA-Army "moderate program" before slippages occurred.

• The 27 *Saturn* vehicles are some dozen or more less than planners originally sought to build. Some had advocated even more.

• The extra launching and test pads are not expected to be available for at least two years. Meantime, an explosion on the present static pad would cripple the whole program.

• The present overtime that has been authorized amounts to possibly $3 million—enough to prevent further slippage when bottlenecks occur, but not enough to speed the program one day.

• Not a dime extra has been requested from Congress for the current fiscal year. Von Braun had sought an extra $60 million.

Therefore, the effect of the proposed increases will generally be to put a rather bobtailed overall *Saturn* program back on the original schedule set up by ARPA and the Army in 1958.

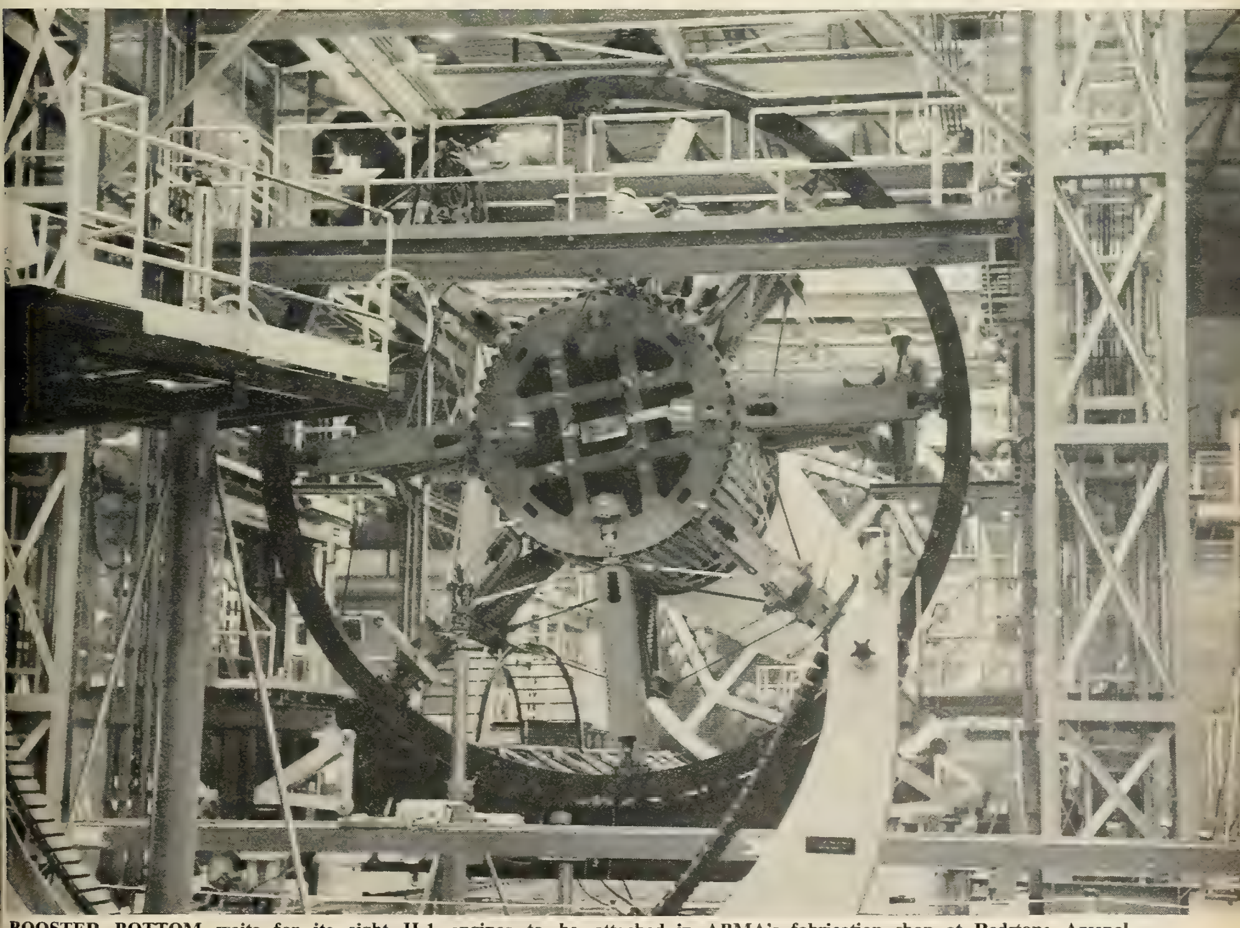
However, the fact that the Administration has even gone this far is considered a victory for official and nongovernment critics who see the 1.5-million-pound-thrust *Saturn* booster and subsequent *Saturn* space vehicles as America's best hope for gaining at least some lost ground in the East-West space race.

Many do not realize how near a thing the killing of the *Saturn* program was last year before it was transferred subject to congressional approval from the Defense Department to NASA along with most of the Army Ballistic Missile Agency at Redstone Arsenal.

At one brief point, only the program's funeral was left to be arranged by the Administration's budget balancers in their search for "marginal military programs" that might be cut.

Until then, ARPA had been able to get funds for *Saturn* on the thinly-disguised argument that the Armed Services needed it to launch large communications satellites about 1965. The Defense Department could not get money for *Saturn* on the grounds that it is needed to beat the Red Air Force into space because the White House does not recognize any need for military space activities beyond a few thousand miles.

Thus, in the end, *Saturn's* military backers had to turn to NASA in order to assure the greatest acceleration possible for *Saturn* under the prevailing circumstances.



BOOSTER BOTTOM waits for its eight H-1 engines to be attached in ABMA's fabrication shop at Redstone Arsenal.

• **Medaris approved**—Maj. Gen. John B. Medaris said on retiring last week as commander of the Army Ordnance Missile Command that he approved the transfer of *Saturn* to NASA only as "the least obnoxious alternative."

"It was better than having it clobbered, for instance," he snapped.

On these grounds, the switch in the eyes of *Saturn's* supporters has already been partially successful. Here is how the new *Saturn* budget requests for FY 1961 now look:

The original request called for a total of $148 million including $8 million for development of a high-energy upper stage.

The supplemental request calls for a total of $98 million including $33.5 million for construction and equipment, $53.3 million for industry R&D contracts, $8 million more for upper stage development and $3.2 million for salaries and overtime.

The new construction money includes funds for the second static test stand at Huntsville and the second launching pad at Cape Canaveral.

Thirty-six firms sent representatives to the first conference on *Saturn* upper stages Jan. 26-27 at Huntsville. Seven attended the second conference at NASA headquarters in Washington Feb. 3.

The first conference was on the 80,000-pound-thrust fourth stage. The second conference was on the 800,000-pound-thrust second stage.

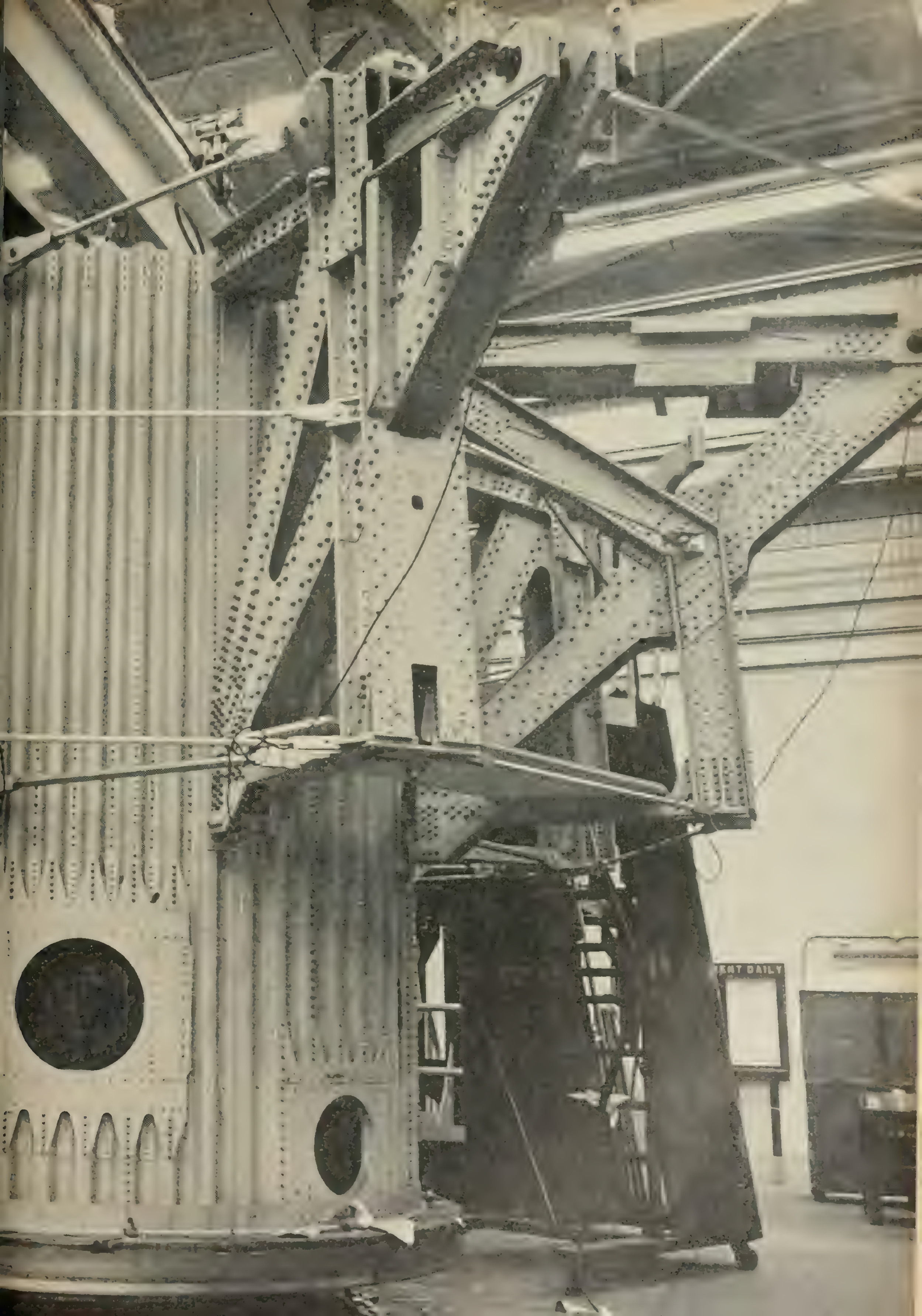
Bids on the fourth stage are due Feb. 29. A contract is expected to be awarded about April 1. No dates for closing the bidding on the second stage have been set. At least one more conference is still to be held on it.

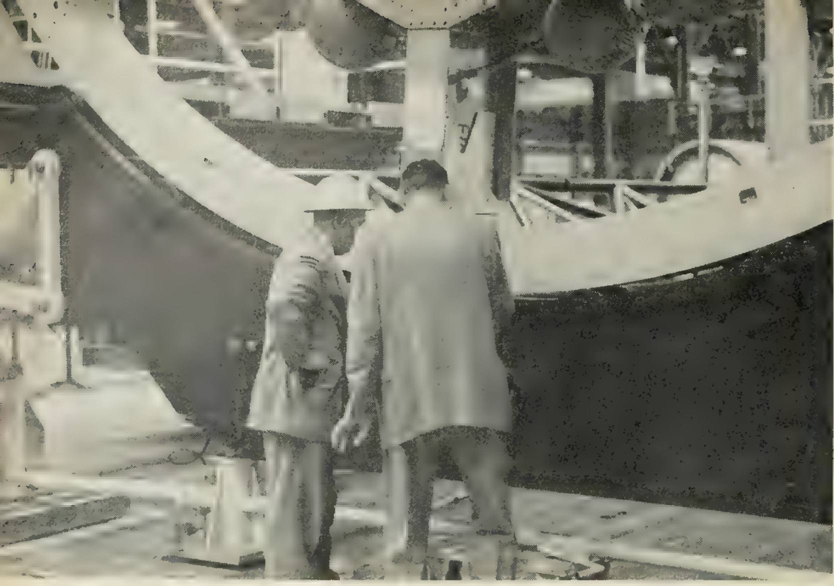
Contractors who were represented at all or part of the two-day conference at Huntsville included:

Bell Aircraft, Bendix Aviation, Boeing Airplane, Chance Vought Aircraft, Chrysler Corp. Missile Division, Convair Division of General Dynamics, Douglas Aircraft, Avco, Firestone Tire and Rubber, General Electric, Lockheed Aircraft, Martin Co., McDonnell Aircraft, North American Aviation, Northrop Aircraft, Raytheon, Sperry-Rand, United Aircraft, Beech Aircraft, Brown Engineering Co., Garrett Corp.;

Minneapolis-Honeywell, Reynolds Metals Co., Allison Division of General Motors, Hickock Electrical Instrument Co., Pratt-Whitney Aircraft, Goodyear, Grumman Aircraft, General Precision, Inc., Aeronutronics Division of Ford Motor, American Ma-

TAIL SECTION of 22-foot-wide *Saturn* gives some idea of the staggering proportions of the 1.5-million-pound-thrust booster. The tail section is topped with eight 70-inch-wide Alcoa aluminum tanks clustered around one 105-inch tank.





HELMETED BOSS, Assembly Operations Chief Max Nowak, discusses progress with associate at the top of partly-assembled *Saturn* booster.

chine and Foundry, Acme Scientific Co., Hayes Aircraft, Walter Kidde, Linde Co., and Fairchild Engine and Aircraft Co.

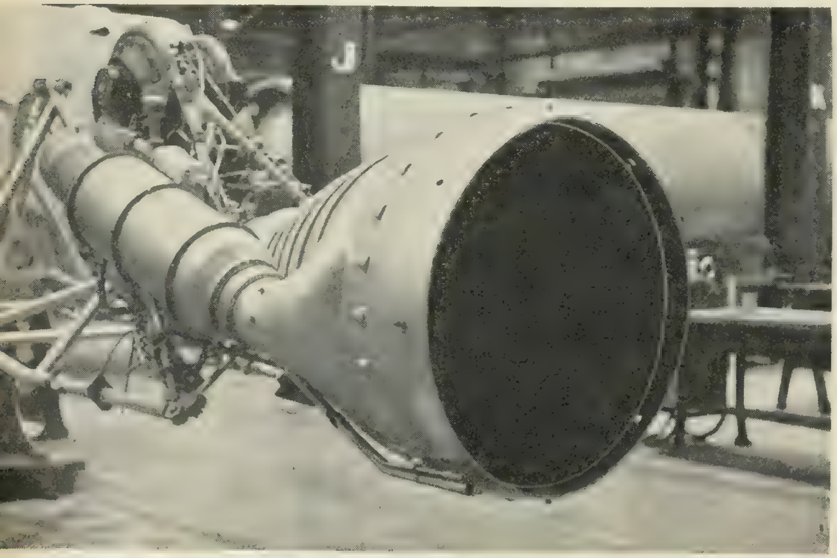
Contractors at the one-day conference at Washington included: Bell, Aerojet-General, Thiokol, Pratt & Whitney, Air Research of Garrett, Rocketdyne and General Electric.

The new second stage—expected to take more than four years to develop—will be a cluster of four 200,000-pound-thrust engines. The new fourth stage—expected to take two years to develop—will be a cluster of four 20,000-pound-thrust engines. It will have a 20-foot diameter—only two feet less than the booster itself.

The third stage will be two 200 K engines. The fifth stage will be two 20 K's.

Under the new schedule, the first *Saturn* with any operational capability in late 1962 is expected to carry the new fourth stage and a dummy fifth stage. Under the old ARPA schedule, the first operational *Saturn* would have carried the much bigger modified *Titan* as a second stage.

The first operational *Saturn* is expected to carry only the eventual fourth and fifth stages.



H-1 ENGINE mock-up sits on floor of ABMA fabrication shop. Each Rocketdyne engine will provide about 188,000 pounds of thrust.

The first 175-foot static test stand has just been completed at ABMA's Test Laboratory in preparation for the first booster test. Assembly of the first booster itself began late last month as individual static tests of its Rocketdyne H-1 engines continued on facilities near the new test tower.

Rocketdyne already has delivered a sufficient number of H-1's for construction of the first eight-engine booster

The day is not far off when the huge 75-foot booster—biggest in the Free World—will be hauled by truck to the test tower and erected with the help of a giant crane. Then with a thundering roar that will shake the earth for miles the booster will be ignited while men cross their fingers.

The finger-crossing is much needed. There is little room for error. If the booster should explode, that will be that for some time to come.

Report Says *Blue Streak* IRBM May Be Cancelled

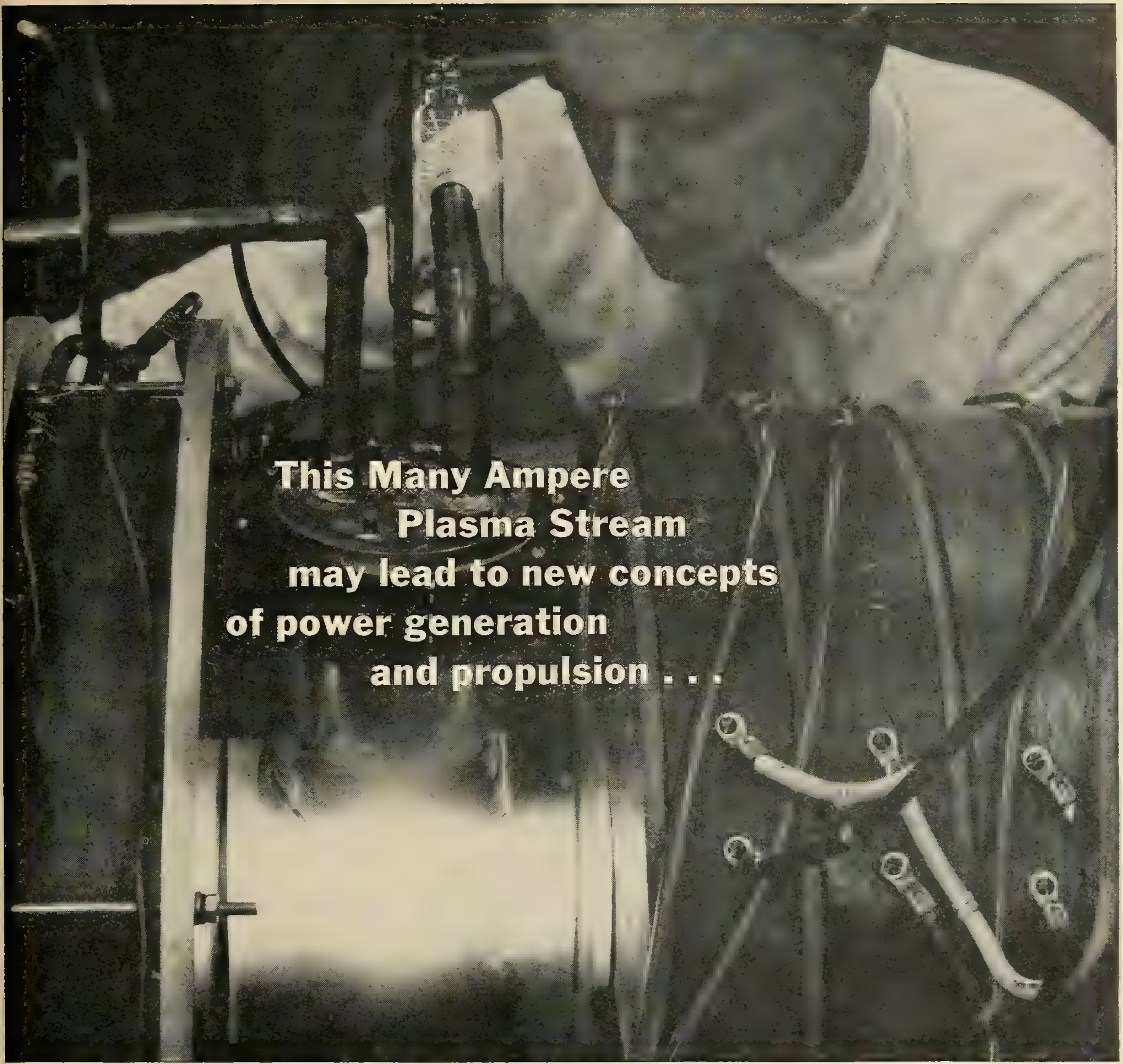
LONDON—A rumour now in circulation says that the new Minister of Defence, Mr. Watkinson, is being pressed to announce the cancellation of *Blue Streak*, the British IRBM.

The Royal Air Force is reported to be alarmed at the vulnerability of such missiles, even if sunk in concrete firing pits, and to believe that few would be likely to remain fit for launching after the first enemy attack. Cancellation should take place soon, before expensive firing trials are started at Woomera.

It is by no means certain that this rumour is true, although a certain amount of resistance to the introduction of missiles is to be expected from the aircraft diehards and from those officers who do not look forward to the personnel changes which must follow.

If the *Blue Streak* program were to be cancelled, heavy compensation payments would have to be made to de Havilland, Rolls-Royce and Sperry Gyroscope. It would also rule out a British satellite-launching vehicle.

Alternatives to *Blue Streak* could be submarine-launched *Polaris*-type missile or a longer-ranged version of the *Blue Steel* stand-off bomb. Either would take several years to develop and further delay the defence program. Furthermore, a considerable amount of capital has already been sunk in ground facilities for *Blue Streak*, both in Britain and in Australia. It thus seems unlikely that cancellation will occur, particularly in view of the excellent performance which is expected of *Blue Streak*.



A many-ampere source of ions, this device is believed to be the most powerful in operation in any laboratory. Already it is providing new insight into thermonuclear fusion. It may lead to new concepts in propulsion including a method of producing thrust for missions beyond the earth's atmosphere.

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NASA Gives Congress 10-Year Plan

$113 million boost asked for FY 1961 for big boosters with 'prestige' programs Mercury, Saturn and Nova getting increases

by Paul Means

In an effort to add appeal to its civilian space program, the Administration last week moved to accelerate eye-catching projects which in time can gain back some of the international prestige lost to the Russians during the last two years.

Two moves in this direction were NASA's request for Congress to increase its Fiscal '61 budget by $113 million (to $911 million), and formulation of a 10-year space program which involves shooting off 263 space vehicles at a cost of about $15 billion.

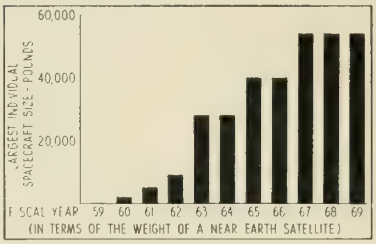
The supplemental, sent to Congress just two weeks after the regular NASA budget, asked for $98 million for the *Saturn* cluster recently acquired from DOD, and $15 million more for the F-1 *Nova* engine.

• **The big three**—Net result is that the three eye-catching projects—the two super booster projects *Saturn* and *Nova,* and the man-in-space Project *Mercury*—have all been accelerated by increased spending. But the Bureau of the Budget's economizing axe cut $123 million out of NASA's other not-so-eye-catching projects.

The supplemental brings the total *Saturn* budget for FY '61 to $246 million—just $4 million short of the figure Dr. Wernher von Braun had asked for. Dr. von Braun made this request last year when *Saturn* was under ARPA management, and hadn't expected to come close to his mark because of DOD's downgrading of super-booster projects. A change of agencies and the chemistry of an election year has given the Huntsville team money beyond their wildest (practical) dreams.

The *Nova* supplemental brings its budget to $41 million in FY '61, and total funding to date now exceeds $71 million.

Payload Weights



Mercury, which had been in critical financial shape during 1959, was funded for $122,750,000 in the FY '61 budget, $19 million in the supplemental FY '60 budget, and has received to date about $300 million.

• **Budget cuts**—But a Spartan regimen is still prescribed for some of NASA's less sensational but equally important projects. NASA officials revealed in testimony before the House Space Committee that their initial budget requests had been cut by $132 million. Some $121 million was carved from part of the FY '61 budget that didn't include *Saturn,* and $11 million was cut from the FY '60 budget.

The figures given reveal that NASA asked for $783 million in its non-*Saturn* part of the new budget, but Bureau of Budget would only allow $662 million. In the FY '60 supplemental, NASA asked for $34 million. The bureau pared this to $23 million.

• **Ten-year plan**—The NASA 10-year plan, apparently predicated on the theory that future administrations will be more generous in support of space research, indicates that the $911 million Fiscal '61 budget is just a starter. Figures indicate that the NASA budget will average $2 billion a year for the rest of the decade.

This point was emphasized before the Committee later in the week by Dr. Wernher von Braun. (See page 12). Admitting that his organization's *Saturn* project now was adequately funded, von Braun stated that he felt more money should be spent for space research in other areas.

"There is always a danger," von Braun told the Committee, "of putting most of the money into weapons systems or space vehicles like *Saturn* and not putting enough money" in less eye-catching but equally important projects. The rocket expert said he would like to see more money in

10-Year Launch Program

(Fiscal Years)	1960*				1961				62	63	64	65	66	67	68	69	
	1	2	3	4	1	2	3	4									Total
Redstone	..	..	..	1	2	3	2	..	..	..	..	..	..	..	..	..	8
Atlas				1	2	1	2	1	6	1	.				.		14
Juno II	..	..	1	..	1	3	..	..	..	..	..	..	..	..	..	..	5
Thor-Able	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	2
Atlas-Able	.	.	.	1	1	.	.			.	.					.	2
Scout				4	2	.	2	..	6	6	6	6	6	6	6	6	56
Thor-Delta			1	1	1	2	1	1	5	.		.	.				12
Thor-Agena B	.			.	..			.	1	6	6	6	6	6	6	6	43
Atlas-Agena B	..	..	..	..	..	..	1	..	3	4	5	6	3	12	12	12	88
Atlas-Centaur	..	..	..	..	..	..	..	1	5	4	5	6	9	..	..	..	..
Saturn	..	..	..	..	1	..	..	..	3	5	1	4	4	4	4	4	30
Nova	.			.	.		..	..	.	..			.		1	2	3
Total		12				29			28	23	25	28	28	28	29	30	263

* Last 2 quarters only.

TOTAL COST—$13-15 BILLION

some of these areas—especially in the area of supporting research.

NASA Administrator T. Keith Glennan told Congress the program is one that will overtake the Soviet space lead—but not for about five years. Glennan estimated that NASA will be able to do what the Russians can do now in about 18 months. Since the Russians are not going to stand still, Glennan estimates that it will be 1965 before the two competing programs are on a par.

• **Ahead in '66**—During the latter half of the 1960's, according to Glennan, the U.S. space effort should hit its stride and go out ahead of the Russians for good.

In bulk figures, the program calls for the firing of 8 *Redstones*, 14 *Atlases*, 5 *Juno IIs*, 2 *Thor-Ables*, 2 *Atlas-Ables*, 56 *Scouts*, 12 *Thor-Deltas*, 43 *Thor-Agena Bs*, 88 *Atlas-Agena Bs* and *Centaurs*, 30 *Saturns*, and 3 *Novas* during the next 10 years.

The first year of the new decade will see attempts to launch the first meteorological satellite, the first passive reference communications satellite, the first *Scout*, the first *Thor-Delta*, the first *Atlas-Agena B*, and man's first flight into space (ballistic trajectory).

Deep space shots during 1960 include the *Thor-Able* interplanetary shot to the orbit of Venus (February), another *Atlas-Able* attempt to orbit the moon (April), and a back-up *Atlas-Able* lunar probe (October).

Project *Mercury* experiments during 1960 include the final *Little Joe* shot, 5 *Redstone* shots (some manned), and four *Atlas* orbital shots. Satellite shots during 1960 include four *Juno IIs*, one *Thor-Able*, three *Scouts*, and three *Thor-Deltas*.

Significant aspects of the 10-year program by fiscal year include:

• FY '61—The first lunar impact, the first *Centaur* launch, and the first manned *Mercury* orbit;

• FY '62—Deep space probes of Venus and Mars, and launch of the first *Saturn* boosters;

• FY '63—Firing of a three-stage *Saturn*, an unmanned soft lunar landing, and an unmanned orbiting astronomical laboratory;

• FY '64—An unmanned moon orbit and return, and unmanned Mars and Venus reference probes;

• FY '65-'67—The first launch in a program leading to manned circumlunar flight and manned permanent near-earth space stations; and

• FY '70+—Manned flight to the moon.

The cost of this ambitious program has been placed by NASA officials at between $12-$15 billion. But soaring costs could put the price tag at well over $20 billion. Considering that figure is only the launching cost of the NASA budget, not taking into account other future expenditures for construction and equipment, salaries, and research and development on newer space vehicles and engines, it is apparent that NASA's annual budget within a very few years could run over $3 billion.

Best available estimates are that the NASA budget will reach $1.5 billion by FY '63, and top $2 billion by FY '65. At least one or two of the space agency's budgets in the late sixties could go as high as $4 billion.

• **Non-political**—The 10-year plan was developed under the direction of NASA's Director of Program Planning and Evaluation, Dr. Homer Joe Stewart. It is calculated to have two results: (1) to stop mounting criticism that the nation has no organized space program; and, (2) to lay down a long-range program that won't be affected from election to election.

Many feel that one of the important needs of the nation's space program is a continuity of effort and support not affected by changing Administrations. Dr. Glennan enunciated this doctrine last week before a GOP fund-raising "Dinner With Ike" at Jackson, Mich.

Pointing out that the nation's space program should not be a partisan political issue, Glennan told the GOP contributors that our "rockets . . . do not bear the insignia of the Republican Party or that of the Democratic Party. They do not carry the name of one of the military services or the name of my agency, NASA. They carry only these words: United States."

• **Future changes**—The plan, according to Dr. Stewart, is to be used as a guide and may be revised as our technology improves.

In presenting the plan before the House Space Committee, NASA Associate Administrator Richard E. Horner pointed out that besides the "uncertainty of financial resources that might be available in the future, there must also be taken into consideration the well recognized fact that the nature and depth of future research and development in any complex technical field are heavily dependent upon the character of prior accomplishments . . . our succeses or miscues . . . will have a commanding influence on the integrity of our plan."

One area in which success might significantly modify the plan is research into newer fuels for rocket engines. The plan does not take into account research presently being conducted on fluorine, nuclear, ion and plasma engines.

• **Variables**—Fluorine engines will probably never be used because extensive research in this field started too late. But nuclear, ion and plasma engines should be operational in this decade, and would then have to find their way into the plan.

Another variable which could modify the plan is *Nova*. *Nova* presently is a 1 to 1.5 million pound thrust engine being developed by Rocketdyne, which is not expected to be ready until the late sixties. The decision has not yet been reached whether to cluster this engine, or whether to use it at all. *Nova*, with its accelerated funding, could be ready earlier than expected, or be cut from the program altogether if newer forms of propulsion systems (nuclear, ion or plasma), improve rocketry to the point where such a large booster is not needed.

The U.S. space program, according to Horner's testimony, will begin to improve rapidly during the 1963-1967 time period because of the *Saturn* cluster. By 1967, the space agency will have the capacity of putting 25 times more weight into satellite orbit than now possible.

Mercury Schedule

Project Mercury

FY	1960		1961				
	3	4	1	2	3	4	Total
Little Joe ..	1	1					2
Redstone ..			2	3	2	1	8
Atlas		1	2*	2*	2*	5*	12

*Orbital.

Deep Space Missions

Fiscal Year	1960			'61			'62	'63
	3	4	1	2	3	4		
Thor-Able	I	.	.	.	.	.	.	.
Thor-Delta	.	.	.	.	.	.	.	.
Atlas-Able	I	L	L	L	.	.	.	.
Atlas-Agena	.	.	.	.	.	L	4L	2
Centaur	.	.	.	.	.	.	..	2P

L—Lunar
P—Planetary
I—Interplanetary

3-Yr. Satellite Program

Fiscal Year	1960 3	4	1	'61 2	3	4	'62	'63
Juno II .	S	..	S	2	S	..	..	..
Thor-Able	M	..	..	..	..	..	..	..
Scout ..	..	S	S	S	2S	..	2S	2S
Delta ..	C	M	S	S	..	..	C	..
	..	..	..	..	..	..	3S	..
Thor Agena B	..	..	..	..	..	..	2M	S
	..	..	..	..	..	..	S	..
Atlas Agena B	..	..	..	..	..	..	..	C
	..	..	..	..	..	..	..	2S

S—Scientific
M—Meteorological
C—Communications

Molecular Warning: 'Research or Die'

Over 20 subsystems developed so far; operational systems are now the goal—Air Force warns parts makers to face up to the need for participation

A joint Air Force-Westinghouse Electric Corp. demonstration of product advances in the "molecular-electronics" applied research program revealed that not only has feasibility been proved, but that the researchers are aiming for operational employment of such systems in from 3 to 5 years.

To further emphasize the tremendous impact of this revolutionary breakthrough, the Air Force program chief, Col. W. S. Heavner, issued a startling warning to the electronics industry. In substance, he said that now is the time for parts manufacturers to make up their minds—accept the inevitability of molecular-electronic systems and initiate research of their own to compete, or die. Admittedly, he said, we shall be using resistors, capacitors, inductors, transistors, etc., in many systems for a long time to come, particularly for high power. But this will represent only a portion of tomorrow's industry, said Col. Heavner.

• **New facts of life**—The business facts of life are that the concept of using molecular structure and atomic field characteristics in materials to perform whole system functions has advanced to the point of producing over 20 functional systems.

These are basic systems ranging from audio, video, dc, and tuned amplifiers to multivibrators and logic switches. Furthermore, these tiny working systems can be reproduced simply and within normal manufacturing tolerances.

The $2-million program will be accelerated, said Heavner, to develop more basic systems and, as soon as possible, to combine these basic elements for even more functionally complex electronic equipments. First on the list probably will be a molecularized radio receiver.

Over 1000:1 size and weight reductions will be possible over anything now available, according to Dr. S. W. Herwald, vice president-research for Westinghouse. Electrical efficiencies obtained are of the order of 70%.

Because such systems would employ a vastly reduced number of total parts, reliability is substantially increased. In addition, the solid-state functional unit itself is very stable and inherently reliable. With use of thermoelectric techniques for power, complete system reliabilities should very closely approach 100%.

• **Break proof**—For future automation, Westinghouse indicated that its controlled dendritic process for growing near-perfect semiconductor ribbons could be made both automatic and continuous over long periods. These multi-zone crystals are the basic building blocks required in molecular-electronic systems.

Plating, etching, and alloying techniques are employed before cutting the dendrites into tiny "parts." By controlling the arrangement of domains and interfaces, or the flow of energy within the semiconductor, the "part" can be made to perform an electronic function by controlling or transforming energy. The concept obviates conventional requirements for circuit elements.

The idea that is so hard to grasp is that the final structure performs a system function. If a piece of material were broken off the element, the system would still function. Only the parameters of the system would be changed.

Navy Demonstrates Satellite Relay

Radio signals bounced off moon's surface to provide complete high-frequency link between Washington and Hawaii

The Navy last week publicly demonstrated the feasibility of using space satellites for communications relay.

In this case, the satellite used was the moon. Radio signals were bounced off its surface to complete a high-frequency link between Washington and Hawaii. Although still an experimental system, the CMR (Communications Moon Relay) has been used by the Navy for operational traffic since last November. It is used to fill the gap when normal traffic circuits are disrupted by periodic ionospheric disturbances.

The Navy experiments show that it is practical to use man-made satellites for communications relay. Several projects in this area are already under way —*Courier, Decree, Steer,* and *Tackle* —under direction of the Advanced Research Projects Agency. Some of these are passive reflectors, like the moon; others will carry radio receiving and transmitting equipment and serve as delayed repeaters.

Satellite relays offer several advantages for long-range communications:

• They are not dependent on the ionosphere for reflection and, consequently, are not subject to the disturbances which often cause fadeouts in conventional circuits.

Messages handled by relay are far more secure from enemy interception and interference. Both sender and receiver must have the satellite in view —a fact which severely limits possible geographical locations for jamming or interception.

Frequencies used are in the upper end of the spectrum where more bands

are available and noise less of a problem. Reliability is a significant advantage at these frequencies.

The CMR system is presently capable of handling multichannel radio teletypewriter and two-way voice and facsimile circuits. It uses the UHF band of 435-445 mc, and a bandwidth of 16 kc. Both stations have separate transmitter and receiver facilities with 100 kw transmitters and 84-foot steerable high-gain (40 db) antennas. Effective radiated power is 440 megawatts.

• **New systems**—Future operational systems, using the moon or artificial satellites, will be vastly more sophisticated and efficient than the experimental relay. Present equipment—mostly off-the-shelf components—must be manually operated and corrected. Corrections for doppler shift, for instance, are cranked in by hand and the antennas steered by an operator.

Future systems will logically include automatic programming to track the antenna and schedule transmissions during suitable portions of the satellite orbit. Proposed 24-hour satellites will remain stationary over one point on the earth's surface to provide uninterrupted relay service. Multiplexing techniques will provide a large number of channels on each link.

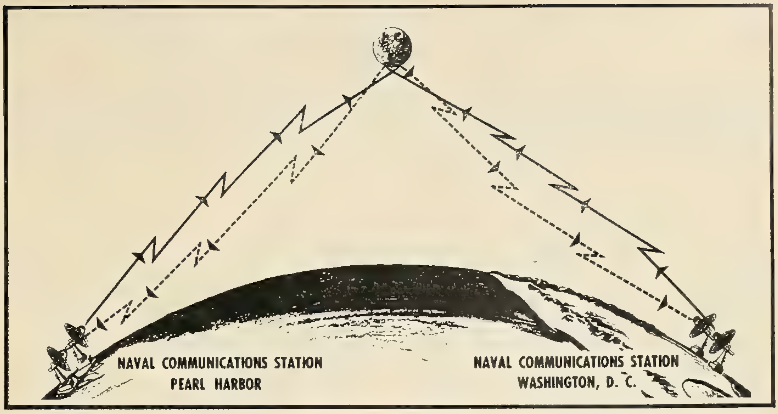
The Navy project grew out of discoveries by Naval Research Laboratory where the feasibility of using moon reflection techniques for communications was demonstrated in 1951.

In 1954, NRL relayed the first CW radio signals via the moon, which was followed a short time later by the successful transmission of voice messages over the earth-moon-earth path. In November 1955, the first transmission and relay via the moon of single-channel one-way radio teletypewriter messages was made from Washington to the West Coast; and in January 1956, from Washington to Hawaii.

The first tests—using makeshift non-steerable antennas and a low-powered transmitter—provided communications of only a few seconds to several minutes. Their primary value was in proving the practicality of systems with high-powered transmitters and directional steerable antennas.

Based on this success, the Chief of Naval Operations directed the establishment of a moon relay circuit between Washington and Hawaii to be used for evaluation of the capabilities and limitations of moon-bounce relays under operational conditions.

In May 1956, the Navy's Bureau of Ships awarded a single research contract to Developmental Engineering Corporation, Washington, D.C., for the development and delivery of an operating communications system to meet performance specifications.



RADIO SIGNALS are relayed by reflection from moon. Transmission time via the relay from Washington to Hawaii was 2½ seconds.

• **Limited**—Operation of the lunar relay systems is limited to periods when the moon is simultaneously visible at both terminals, ranging from a few hours up to a maximum of about 12 hours. Operating schedules are established by determining the time of moonrise at the western terminal and moonset at the eastern terminal.

During these periods, and when the circuit is not being used in research projects, the Navy expects to use it for handling regular traffic to and from Hawaii.

The system is now considered to be under operational evaluation, but is in readiness for use in transmitting operational traffic when solar disturbances affect conventional radio circuits. The system was first used in such an instance last November when particularly bad ionospheric disturbances disrupted regular communications.

Navy says that eventually the moon relay principle may be adapted to sending and receiving messages from ships at sea or to man-made satellites.

Cost of the pilot system, including construction of facilities and other construction, was approximately $5.5 million.

Major subcontractors to DECO in the CMR project include Scatter Communications, Inc., Bethesda, Md.; Continental Electronic Mfg. Co., Dallas, Texas; D. S. Kennedy & Co., Cohasset, Mass.; ITT Laboratories, Nutley, N.J.; General Bronze Corp., Garden City, N.Y.; and Eitel-McCullough, Inc., San Carlos, Cal.

THIS PHOTO of USS Hancock (CVA-19) was the first official photograph to be transmitted by radio facsimile via moon-bounce.

Outlook Good for Frequency Control

Ad Hoc Group of the International Telegraphic Union has already set aside bands for space use and other agreements are likely to be made without difficulty

The 1960's will be the decade when lawyers and diplomats take their place alongside engineers and scientists in an attempt to effect laws regulating the space frontier.

The first "space laws" that will be obeyed generally by world powers will deal with frequencies for space transmission. The early spade work was accomplished last fall by the International Telegraphic Union.

Other laws to be considered by the ITU include provisions for shutting down radio emissions from satellites and other space vehicles at an appropriate time, and of identifications for radio emissions from satellites and other space vehicles.

• **Basic problem**—The basic radio problem created by the space age is the need to find frequency bands for space use in a radio spectrum already burdened by military and commercial communications.

An Ad Hoc Group of the 100-nation ITU decided at Geneva to reserve for space use those bands already being used by the U.S. and USSR. These bands are:

• 5 Mc/s, 10 Mc/s, and 20 Mc/s in the upper guard band of Standard Frequency Service transmission, with a bandwidth not to exceed 2 kc/s, for ionospheric research;

• 19.993-5-7 Mc/s, and 20.003-5 Mc/s, with a total bandwidth of about 20 kc/s for ionospheric research and telemetry;

• 21 Mc/s with a bandwidth of about 5 kc/s for ionospheric research;

• between 27.5 Mc/s and 30 Mc/s with a bandwidth of about 50 kc/s for ionospheric and meteorological research, and telemetry;

• 39.986 Mc/s, and 40.002 Mc/s with a total bandwidth of about 40 dc/s for ionospheric research, telemetry and tracking;

• between 130 Mc/s and 140 Mc/s with a bandwidth of 1 Mc/s for telemetry and tracking;

• 183.6 Mc/s with a bandwidth of 1 Mc/s for telemetry and tracking.

The five nations on the Ad Hoc Group—the U.S., the U.S.S.R., France, the United Kingdom, and Czechoslovakia—agreed to the above frequency allocations and bandwidths for space with the stipulation that the transmissions are to be on a non-interference basis to other services.

• **Reds object**—The Russian and Czechoslovakian delegations recommended that the ITU not allocate specific frequency bands for space research above 200 Mc/s at the present time. Though they had no objections to these higher frequencies being used by other countries, the Soviet delegates felt that further technical information and experience should be available before such allocations were made.

The U.S., French and British delegations made the recommendation that the following frequency bands above 200 Mc/s be allocated for space research:

• about 400 Mc/s with a bandwidth of 1 Mc/s for telemetry and tracking;

• between 15,000 Mc/s and 16,000 Mc/s with a bandwidth of 100 Mc/s for space relay research and meteorological research;

• between 30,000 Mc/s and 32,000 Mc/s with a bandwidth of 300 Mc/s for space relay research and meteorological research;

The French and British delegations proposed allocation of a frequency band at the top of the hydrogen-line band (1400 Mc/s-1427 Mc/s), but the U.S. delegation believed that it was not feasible to share any part of this band for space research.

The U.S. delegation proposed the allocation of three band of 20 Mc/s width between 1700 and 2500 Mc/s, but the French and British delegations only wanted two allocations of 1801-1821 Mc/s and 2084 to 2104 Mc/s.

The U.S. and British delegations proposed the allocation of a 100 Mc/s bandwidth between 8000 Mc/s and 9000 Mc/s, but the French had certain reservations.

The Group as a whole agreed that it will be necessary to convene an Extraordinary Administrative Radio Conference of the ITU in late 1963 to make provisions for new services and methods of telecommunications using space vehicles. They suggested that the conference decide on allocation of frequency bands for the various categories of space telecommunication, consider whether some frequencies for space use are any longer needed, and adopt certain regulations to provide for identification and control of radio emissions from space vehicles.

The Group also requested that the ITU's Radio Consultative Committee (C.C.I.R.) study the desirability of identifying radio emissions from space vehicles, and also the desirability of providing regulations for the shut-down of radio emissions from space vehicles.

And it asked that those nations launching satellites—namely the U.S. and the U.S.S.R.—keep the ITU informed of frequencies used and technical progress achieved in use of telecommunications for space reesarch.

• **Permanent signals**—The problem of permanent power sources in satellites first arose when the U.S. Navy launched *Vanguard I*. The satellite's batteries were charged by solar cells, allowing it to send signals back to earth ad infinitum.

Because of its almost perfect orbit, *Vanguard I* still provides useful information. But when the value of its information is ended, there is no way to turn off *Vanguard I's* transmitter.

And a great many satellites in space with permanent power sources would clutter up valuable frequency bands for many years to come.

Explorer VII, the long-life radiation experiment satellite, has a destruct mechanism which will turn its transmitter off after one year of operation.

Methods which can be used to terminate a satellite's signal are: (1) using a circuit breaker; (2) applying too much voltage to a transistor, or (3) using a time fuze or mechanism.

• **Hopeful**—Since the Soviet Union is the only other space power, the outlook is good that the ITU will be successful in regulating space transmissions.

The communications experts point out that to date neither nation has much of a vested interest in space, and that the ITU so far has had little difficulty in bringing about international agreements on frequency allocations. (See M/R, June 1, p. 26.)

Norair Proposes All-Plastic Rocket

by Frank G. McGuire

HAWTHORNE, CALIF.—An all-plastic rocket utilizing a plastic solid propellant and a minimum of metal parts has been presented for industry consideration by the Norair Division of Northrop Corporation. Some of its advantages would be resistance to radar and infrared detection, low fabrication costs, good insulating qualities, light weight and high strength.

Although the firm has not formally proposed the project to a government agency or settled on a particular configuration, materials research indicates that the project is feasible.

A paper presented at the 15th Annual Conference of the Reinforced Plastics Division of the Society of the Plastic Industry listed materials for the vehicle. Northrop's Harry Raech, Jr., of the Materials Research Laboratory, enthusiastically endorsed the use of plastics, commenting: "We are entering a period where it is possible that metals will be as rare in missile structures as wood now is in aircraft."

Properties of Modified Phenolic Laminates

Material	Edgewise Compressive Strength, Psi: Ambient	1000F
181 Glass Cloth/192 Resin	10,000	300
Refrasil C-100-28 Cloth/192 Resin	32,600	6,100
181 Quartz Cloth/-192 Resin	5,700	1,600
28 x 28 Graphite Cloth/192 Resin	2,150	340

• **Increased efficiency**—The nose cone of the proposed vehicle would be a quartz-fiber-reinforced phenolic, about 40 times as effective as the same weight of copper in heat dissipation. The motor casing would be a filament-wound fiberglass epoxy, which Raech estimates would be twice as efficient as a metal casing. An exit nozzle of graphite-cloth-reinforced phenyl silane would provide good stability and ablation-resistance at 5000°F or higher.

Propellant utilized would be polysulfide/perchlorate, insulated with a liner of asbestos phenolic. The outside liner of rigid plastic foam would have an erosion shield of refrasil-reinforced modified phenolic. All guidance equipment would be potted in silicone rubber, and the payload compartment constructed of fiberglass honeycomb sandwich, chosen for its low thermal conductivity and its high strength/weight ratio.

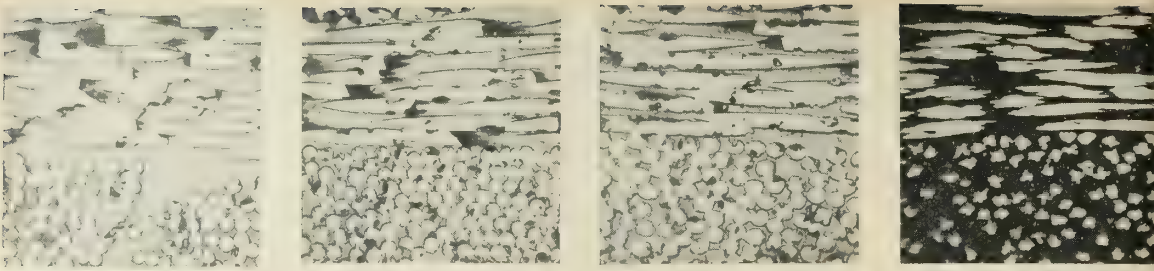
The only metal parts used in the vehicle, says Raech, will be electronic components and a few fasteners.

• **Heat resistance emphasized**—Thermal properties of plastics represent "one of the most compelling reasons" for considering their use in structural members, according to Northrop, because of the unusual environmental situations in which such a vehicle would have to have exceedingly high performance.

The paper, representing work conducted at Norair's Materials Research Laboratory, covers a considerable number of structural materials feasible for use in a rocket vehicle, pointing out that any such material should possess the highest possible specific heat and the lowest possible ratio of thermal conductivity to mass.

Although plastics would be expected to provide better insulation than metal, their high specific heat—equivalent to that of most metals—is an unexpected bonus, according to Raech. He points out that reinforced plastic is second to no other material in specific strength properties.

Two classes of heating problems are expected to arise in the proposed vehicle: short- and long-time effects. The former is taken to mean time in seconds or a few minutes. This class is the less serious of the two; materials already developed can cope with it. Up to 800°F, there are a number of re-



PHOTOMICROGRAPHS illustrate failure of reinforcing fibers in refrasil and quartz materials. Glass and graphite display no degradation, presenting smooth rounded filaments and showing no discontinuities. The siliceous materials, display a "crystalline" structure with cracks and crevices. Whether the faults are true devitrification or are stress-induced is impossible to determine.

inforced plastics capable of doing the job.

Even short-time temperatures as high as 6000°F can be satisfactorily met with sacrificial cooling. This approach utilizes heat of fusion or vaporization for surface cooling and is most useful in contact with high-velocity, high-temperature gaseous streams. Its utility is demonstrated by a typical fiberglass ablation surface, which will absorb approximately 6000 BTU's for each pound ablated.

• **Divided opinion**—Two schools of thought exist on this subject. One holds that structures should, in their entirety, contribute to pyrolytic cooling. The other feels that a method using pyrolytic resins bound together and supported by a relatively stable net such as refrasil cloth would be more effective. This latter group favors formation of bound graphite, which, in maintaining integrity, acts as a thermal barrier while still allowing transpiration of cooling vapors of pyrolysis from substrates.

In the long-duration applications, an intensive search is under way for reinforced plastics which can operate effectively in temperatures over 500°F for extended periods. Presently, temperatures over 800°F can be met, but these will be greatly exceeded in future space vehicle environments.

Norair is conducting an intensive applied research program, utilizing its ability to carry on extended-duration tests at temperatures ranging from −100°F to 2000°F.

• **Fiber weakness**—One of the major problems involved in the search for high-temperature reinforced plastics is the relative weakness of the reinforcing fibers. In certain areas of structural stress, the fiber rather than the resin has imposed limitations.

In a study of various reinforcing fibers, Norair took photomicrographs of several fibers, which revealed glass and graphite suffering no degradation. Both materials maintain smooth rounded filaments and show no discontinuities.

Both refrasil and quartz, however, showed a crystalline structure with cracks and crevices. It cannot be determined whether these flaws result from true devitrification or are stress-induced. Raech notes that anticipated strength levels have not been achieved in the laboratory.

• **Epoxy gains**—Progress in epoxies has been considerable; the versatility of these polymers has been greatly expanded in the past year. Great hope is held out for some of the most recently developed combinations.

Previously, epoxies could not be depended upon for lengthy service at temperatures over 300°F, despite their relatively high strength levels. This situation has improved somewhat, and current service levels are over 400°F.

The belief that 750°F is the upper

Strength/Weight Ratios Of Some Structural Materials

Material	Specific Tensile Strength, Inches X10-6
Aluminum, 7075 T6	0.72
Magnesium, AZ51X	0.55
Steel, 4130	0.69
Fiberglass Cloth (181) Epoxy	0.85
Fiberglass Filament Winding	1.40

Some Properties of Laminates For Use To 800F*

Resin	Temperature, °F	Time, Hours	Tensile Strength, Psi	Edgewise Compressive Strength, Psi
Epoxy, Epon 828	70	..	55,000	54,000
Epoxy, Epon 828	400	200	25,000	5,000
Phenolic, 91LD	500	½	52,000	40,000
Phenyl Silane, 37-9X	600	½	34,000	22,000
Phenyl Silane, 37-9X	800	½	....	9,700
Silicone, DC 2106	70	.	46,700	16,100
Silicone, DC 2106	500	½	30,700	5,000
Silicone, DC 2106	800	9	18,100	3,000

*All laminates made with 181 E-Glass fabric, properties given for the warp direction.

Thermal Properties Of Some Space Materials As Measured At About 200° Fahrenheit

Material	Conductivity	Specific Heat	Density	Specific * Conductivity	Heat Sink ** Coefficient
	k	C	d	1/kd	Cd
	$\frac{BTU}{°F\ in\ hr\ ft^2}$	$\frac{BTU}{lb\ °F}$	$\frac{lb}{in^3}$	$\frac{in^2}{BTU\ °F\ ft^2\ hr}$	$\frac{BTU}{in^3\ °F}$
Aluminum, 24S	98	.22	.098	.105	.022
Beryllium	85	.52	.066	.179	.034
Copper	211	.09	.320	.015	.028
Graphite	79	.17	.050	.253	.085
Magnesium	84	.25	.064	.187	.016
Steel, 4130	11	.13	.290	.313	.038
Fiberglass Epoxy†	.89	.24	.063	17.9	.015
Fiberglass Polyester	.97	.28	.066	15.7	.018
Fiberglass Phenolic	.87	.25	.059	19.7	.015
Fiberglass Silicone	1.02	.24	.059	16.5	.014
Refrasil Mod. Phenolic	2.3	...	.060	7.3	...
Urethane Foam, Rigid	.48	.41	.006	347	.002

*Higher values connote efficient insulators weightwise.
**Higher values connote efficient heat sinks weightwise.
†All laminates reinforced with fabric.

limit of temperature stability for purely organic systems is being attacked through research into polymers not based on carbon linkages. This stems from development of the metal chelate concept and of coordination bonding.

A continuous effort is being made to upgrade the conventional thermosetting resins—the epoxy, polyester and silicone types—with Hooker Chemical Co. achieving 90% of initial strength at 500°F. The figure is 40% for equivalent hydrogen-glycol-polyester laminates. Strength retention in Hooker's work is 65% after 100 hours at 500°F, as contrasted with 30% for corresponding hydrocarbon polyesters.

Scientists at Quantum, Inc., have produced organic polymers with good temperature stability at over 750°F. These were of the ammeline and melamine families. It is believed that future work may produce polymers stable in the 1000°F to 1400°F range.

Similar work at the University of Florida has produced a synthesized series of hydrazine polymers, all of which are stable at over 700°F. One of these, a co-polymer of perfluoroglutaroimidine and perfluorobutyramidine, is expected to exhibit stability at 750°F.

• **Metal research**—Organometallics now under study are expected to show desirable properties after further work.

Thermal Stability Points Of Some Polymers

900F	*Dicyclohexyl Phosphino Borane Trimer Polyaluminoxanes*
750F	*Melamine Phosphorus Pentachloride Naphthazarin Theiosemcarboazone-Nickel Complexes Perfluoroglutaroimidine-Perfluorobutyramidine Copolymers Phthalyl Bis-(B-Hydroxethyglycene) Zinc Chelates Zinc Coordination Polymers*
700F	*P-Biphenyl Isocyanurate*
650F	*Bis (5-Phenylhexamethyltrisiloxanyl) Ferrocene Trichelated Aluminum Polymers*
625F	*Diphenyl Silane Polymers*
575F	*Alkyl Phosphines 3-Methylvinylcyclohexane Phosphinoboranes Phosphorus-Nitrogen Polymers*
550F	*Epoxies (Improved)*
525F	*Sulfur-Nitrogen Compounds*
500F	*Melamine-Sulfamide Formaldehyde Polymers Polyphenyls*
475F	*Dodecamethylstannopentane*
450F	*Fluorinated Alkyd Polyesters*
400F	*Diamminedichlorozinc Polymers Ferrocene-Bromosilane Polymers Pentaphenylantimony-Nickel Carbonyl Polymers*
300F	*Nickel Salicylaldehyde Diamine Polymers*

A number of companies and government facilities are researching with aluminum, iron, nickel, phosphorous, silicon, sulfur, tin, zinc and other materials in an effort to perfect these organometallics.

Trichelated aluminum polymers expected to be stable at 680°F have been prepared at Morton Chemical Co., and are being evaluated at Norair. Similar work with polyaluminoxanes at U.S. Borax Research Corp. has produced polymers withstanding 900°F, which appears to be the temperature limit of existing reinforced plastics, although extensive work is under way in numerous laboratories.

Temperature resistance qualities of reinforced plastics are being constantly raised, through work supported to a large extent by the Defense Department.

Recalling that nearly all the commonly used metals of today have temperature limits of 2000°F, Raech concludes: "It may not be too much to expect that the high-temperature materials of the future may be the plastics. Time and research alone will tell."

propulsion engineering

GCR Starts Production of Nitrasol

Action makes company formidable contender in AF's big booster program. Decision of contractor imminent with hybrid system possible

Grand Central Rocket Co. of Redlands, Calif., last week started pilot production of a new high-energy propellant—Nitrasol. The action apparently boosts GCR as a formidable contender in the Air Force competition for the multimillion-pound-thrust solid space booster. (M/R, Nov. 30, p, 21.)

The booster—which now stands a better than average chance of becoming a hybrid liquid-solid—is undergoing final evaluation of bids by Air Research and Development Command. Bid deadline was Dec. 15. A decision on the competition, which would give the Air Force its own boost system independent of National Aeronautics and Space Administration scientific vehicles, is expected to be announced at any time. To date, it is believed, no specific requirement has been spelled out for these motors.

Funds for the project would come from Air Force money programmed for R&D in improving existing solids combinations. It is estimated that the first phase of the big booster program (which is essentially a feasibility study) would cost between $4 and $8 million. Three to five motors presumably would be delivered. The entire cost over a three-year period would be in the neighborhood of $35 to $40 million.

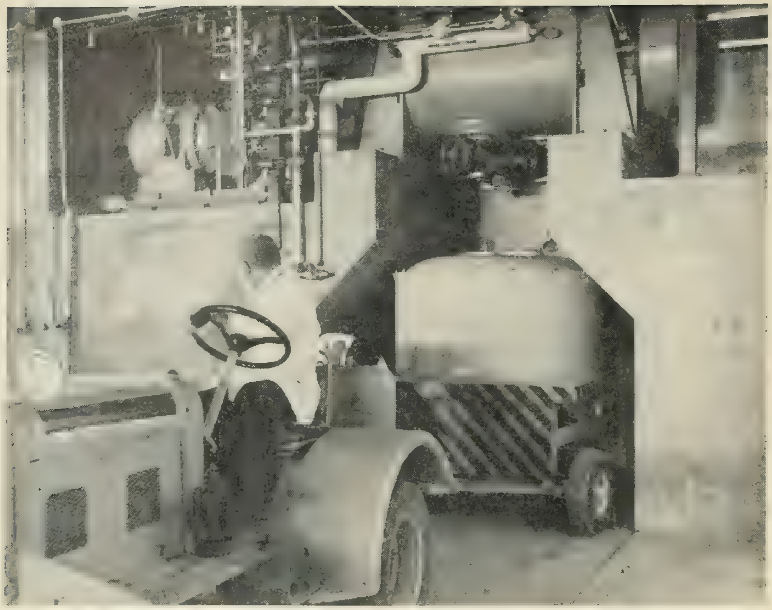
• **Hard look by Congress**—The big solid undoubtedly will get a careful scrutiny from Congress during forthcoming appropriations hearings, with the Air Force undoubtedly having to prove its need for such a system.

The main point which will be stressed is that Air Force needs such a vehicle within three years to carry out its military responsibilities in altitudes up to 600 miles. The Administration has told AF to leave the area beyond 600 miles for scientific research by NASA.

Many in industry feel that unless additional funds are forthcoming, the Air Force will be borrowing from Peter to pay Paul with existing solids research suffering while R&D funds go to the big booster.

Grand Central reportedly has measured I_{sp} of between 250 and 260 seconds with the Nitrasol mix, originally developed by Naval Ordnance Test Station at China Lake, Calif. An AF spokesman said the Nitrasol competition is decidedly in the running for the big booster and also is being considered for product improvement of several missiles.

He said Nitrasol has just as interesting physical characteristics, as it has high specifics and it could easily become competitive with the "blue sky" propellants which the Advanced Re-



GCR is now operating the world's largest mixer at Redlands.

search Projects Agency is investigating within the 285 I_{sp} range.

• **Ganging up?**—M/R has learned that Marquardt Corp. has teamed up with GCR. The team approach, which both companies will not confirm or deny, reportedly is a hybrid design with the solid inert—thereby insuring safety in transport, which could be done in sections. As one spokesman said, "casting at the site is a crutch that no one really wants to go to." However, the GCR/Marquardt proposal reportedly includes site casting if the Air Force so wishes.

Many in industry believe Air Force will go to a 2- or 3-million-pound booster rather than stay in the vicinity of 1 million pounds of thrust. This is based on the fact that many solids people believe the Air Force system could be available before either the clustered *Saturn* with eight H-1 engines, or the single chamber 1-million-pound E-1 engine. Both are Rocketdyne products.

Some solids proponents point out that a 100-million pound/sec. unit would cost only ⅕ as much to develop as a comparable liquid size unit. Production costs, they say, would only be one-half as much.

Grand Central has said it can build a large grain free of stress at ambient temperature, which would ease storage and transport problems. Factors stressed on behalf of the liquid-solid hybrid system are: controllability with half the plumbing of pure liquid systems, safety, more BTU in a given package, and the old argument—simplicity.

It is understood that Marquardt's part of the team includes liquid and mechanical systems and nozzle. GCR would do loading selection of solid propulsion materials.

• **Funding offer**—An unusual feature of the whole big booster competition is that when the Air Force asked for bids ata a secret meeting last November at Edwards AFB, it stressed that it was interested in "sharing the cost"—not only in new facilities, if the contractor has need for them, but in actual R&D and production.

Other bidders include Thiokol, Aerojet, Hercules Powder, Astrodyne, Atlantic Research and Olin-Mathieson. A few of these companies have also submitted proposal advocating solid-liquid hybrid systems.

One company's bid reportedly is the "dollar-plus," which his competitors are criticizing as an effort to get a contract which could prove detrimental to the entire propulsion industry. The complainant said such a bid could well lead to opinions from Congress that the propulsion industry is "getting fat on contracts" and should furnish more than its fair share of facilities expansion and R&D costs. "This couldn't be farther from the truth," the spokesman said, "as I look at our own production, far below our plant's capabilities."

• **Varied proposals**—Papers presented at recent technical meetings have proposed many large booster systems. At the American Rocket Society's November meeting, John Gustavson of GCR outlined details for construction of a 2.4-million-lb.-thrust solid motor which would burn 72 sec. at a thrust-to-weight ratio varying from 2.5 to 7.9. The 691,000-lb. booster would be 90′ long and 12.5′ in diameter and would perform at 265 I_{sp} between sea level and altitude burnout.

Earlier, at a symposium on Advanced Propulsion Concepts held in Boston, Dr. Harold Ritchey of Thiokol proposed a solid booster of 10-million-pounds-thrust and 60 sec. duration. It would have a total impulse of 600-million-pound-seconds, comparable to a liquid rocket generating 3 1/3-million-pounds-thrust for 180 sec.

Aerojet-General (M/R, Jan. 11, p. 13) proposed a huge booster which could place 25 tons of useful payload in orbit within eight years. In the neighborhood of five million pounds thrust, it would have a diameter of about 20 feet. The firm said it has spent approximately $250,000 in company funds during the past year to study big booster systems.

And on Jan. 29, Rocketdyne engineers outlined at an American Rocket Society meeting a series of approaches for building a two-megapound thrust booster that would burn 90 sec.

Lockheed Acquires 50% Of Grand Central Rocket

Announcement was made last week by Lockheed Aircraft Corp. that it has reached an agreement to acquire 50% interest in Grand Central Rocket Co.

No terms of the agreement were disclosed beyond a statement by Lockheed Chairman Robert E. Gross that the company expects to pay cash for the GCR common stock which it acquiries.

Gross said the acquisition is aimed at rounding out Lockheed's missile, satellite and spacecraft capabilites. Recently, Lockheed Electronics Company was formed as a wholly owned subsidiary, combining Stavid Engineering, Inc., acquired in May, 1959, and Lockheed Electronics and Avionics Division, formed last March.

Only last week, GCR started up the world's first pilot production facility of the high-energy propellant, Nitrasol, regarded by many as a formidable contender. (See preceding page). The propellant mix is also believed to have a good future in product improvement of many existing solid motor systems.

GCR, founded in 1955, became a subsidiary in 1958 of Petro-Tex Chemical Corp. of Houston, jointly owned by Food Machinery and Chemical Corp. and Tennessee Gas Transmission Co. Under current plans Lockheed and Petro-Tex will share equal ownership of GCR. No personnel changes are contemplated.

Rocketdyne Details Solid Booster Plan

by Jay Holmes

PRINCETON, N.J.—A group of engineers for Rocketdyne has proposed three approaches to building a solid-propelled booster generating two million lbs. thrust. The proposal was outlined at the American Rocket Society Solid Propellant Conference here Jan. 29.

Although the North American division's spokesmen did not say so, most listeners assumed the plans outlined were in their company's proposal in the current Air Force competition for a large solid booster.

J. E. Medford, a senior analysis engineer at Rocketdyne's Solid Propulsion Operations in McGregor, Tex., read the paper, which was co-authored by A. B. Boyd, design engineer and W. M. Burkes, design supervisor.

The paper, entitled "Grain Design and Development Problems for Very Large Rocket Motors," outlined ways of building a two-megapound rocket that would burn 90 sec. Assuming specific impulse of 250 sec. and pressure of 500 psi, they came up with plans for a motor 15′ in diameter and from 64′ to 66′ long depending on internal grain design. Propellant would weigh 360 tons.

• **Going with the grain**—The three designs Medford discussed are the single grain, the compartmented grain and the modular grain. The single grain would be a simple scale-up of present large solid rockets with the propellant bonded to the case. It would have to be cast at the launch site. A compartmented grain would also be case-bonded and cast on site. But it would be separated into compartments by support structure. The modular grain would be an assembly of several propellant modules cast and cured as separate pieces. The modules need not be cast on site.

The Rocketdyne engineers declared that all three approaches are feasible but that the case-supported single grain is preferred because it is the simplest to fabricate. However, propellants with good physical properties will be needed for such a design.

Medford said new butadiene-based propellants under development at McGregor have physical properties that make them ideal for use in a very large motor. The company said butadiene propellants have greater resistance to tear and strain, less tendency to slump and better case-bonding capabilities than present-day polyurethane propellants.

Both the compartmented and modular designs offer solutions to the structural problems involved in using propellants of lesser physical properties, they added. In addition, they concluded, the modular grain provides the advantage of favorable conditions for fabrication, inspection and quality control.

The Rocketdyne proposal was the third in about a week to come to notice. M/R learned this week (page 29) that Grand Central Rocket Co. has started pilot production of a new high-energy propellant in an effort to jockey for position on the Air Force big solid booster competition. And United Aircraft's United Research Corp. announced it has invented and perfected a method of building up a large solid rocket from segments (M/R Feb. 1, p-11). Thiokol, Aerojet-General, Hercules Powder Co., Olin Mathieson and Atlantic Research Corp. also attended an ARDC briefing on the proposal at Edwards AFB last fall. However, Atlantic Research decided not to bid.

For all three designs, the Rocketdyne engineers assumed that the motor case would consist of a wound glass fiber, reinforced plastic cylindrical section with a metal flange at the aft end, which connects by tension bolts to a formed metal aft head. The case would be helically wound on site to avoid transportation difficulties.

The case would operate at a stress level of 70,000 psi. Medford and associates did not detail how the fiberglass-plastic combination would be bonded to the metal aft head.

For the case-supported single grain, the Rocketdyne group postulated a five-pointed star cut in the 90″ radius cross-section. Web thickness would be 36″, inner radius would be 18.8″ and fillet radius would be 2″. They calculated that the grain would slump 0.327″ at the innermost boundary due to its own weight 100 minutes after being set on end.

• **Compartmented grain**—The star point stress concentration also may be eliminated by the design of a compartmented grain. Such a grain is separated into sections so that it no longer acts as a homogeneous mass. The star point stress is eliminated by adding an expansion joint at the star base or the base corners.

An additional advantage in adding a joint in is the reduction of grain sliver—the unburned propellant remaining at the start of thrust decay.

• **Modular grain**—Although both case bonded and mechanically suspended modular grain approaches are possible, Medford and associates considered only the mechanically suspended. Such a design has many advantages, they said, which include:

• Casting and curing by conventional methods in a company's own home facilities, making possible cost savings.

• Small mass and accessibility allow easier and more thorough inspection.

• Defective individual pieces can be scrapped at relatively small monetary loss.

• Modules could be cast in transportable size.

The Rocketdyne engineers suggested casting the modules around a support structure, which would have male and female fittings at either end. Then the modules could be connected end to end to form a column.

Different arrangements of internal support can be used in different modules, depending on the geometry, burning surfaces, physical properties and load to be carried. Non-burning surfaces would be coated with inhibitor to prevent uneven burning.

Motor Design Summaries

	Monolithic Grain	Compartmented Grain	Modular Grain
Thrust, lb.	2,000,000	2,000,000	2,000,000
Duration sec.	90	90	90
Pressure psi	500	500	500
Assumed I_{sp} sec.	250	250	250
Case OD ft.	15	15	15
Case Cyl. length ft.	53	53	51
Overall Motor length ft.	66	66	64
Propellant Wt. lb.	720,000	720,000	720,000
Total Wt. lb.	775,000	790,000	800,000
Mass Ratio	.93	.91	.90

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Through molecular electronics, drastic reduction in weight, size, power and heat dissipation requirements will permit space vehicles and satellites to perform a greater number and wider range of tasks. Greatest advantage is the vastly improved reliability achieved by the replacement of numerous components by a single solid state unit.

Recently, the Air Research and Development Command of the U. S. Air Force awarded a development contract to Westinghouse as a part of a broad program effort in this new electronic area. Experimental "hardware" is being fabricated by Westinghouse for infrared, reconnaissance, communications, telemetry, flight control and other military applications.

"Missiles and Rockets deals exclusively with astronautics. Spawned by aviation, missilery and outer space exploration today is an industry by itself." — George Shapiro (right), Fellow engineer of the Westinghouse Astronautics Institute, located at Air Arm Division.

"One company can't build the entire bird . . . it takes thousands of pa
and scores of companies. Missiles and Rockets keeps us informed of
products and capabilities of the other companies throughout the ind
try — a most definite aid in selecting contractors." — Harvey Sa
(right), Manager, power systems, Westinghouse Advanced Syst
Planning group.

Gene Strull (right), Manager of the Semiconductor Divi-
's Solid State Advanced Development Laboratory at the
tinghouse Air Arm Division, discusses molecular elec-
ics with Charlie LaFond of the editorial staff of Missiles
Rockets magazine. Westinghouse engineers have devel-
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ronautics) demands week-to-week technical and
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Lockheed Shows Advanced *Agena*

Test firing made of Bell liquid engine which will have restart capability in space. In-flight test due next month at Canaveral on Atlas

by William J. Coughlin

SANTA CRUZ, CALIF.—An advanced *Agena* satellite vehicle capable of engine restart in space was unveiled in a test firing Jan. 27 at Lockheed Missiles and Space Division's $10-million 4000-acre test site on Eagle Mountain.

Lockheed said the new liquid-fueled engine system is the first which will permit a heavy military satellite to change its orbit. It described the advanced satellite and its Bell Aircraft Corp. engine as a breakthrough in space technology.

Agena, first satellite to change attitude on orbit according to program, thus also becomes the first capable of changing orbit.

Initial in-flight test of the system will come next month when it is to be boosted into orbit from Cape Canaveral by a Convair *Atlas*.

The large *Agena B* carries approximately 17,000 lbs. of inhibited red fuming nitric acid and UDMH, double the fuel capacity of the basic *Agena*, which is 19 ft. long and five feet in diameter. Size increase of the *Agena B* resulting from the double tankage is chiefly in length. Engine thrust of both *Agena* vehicles is 15,000 lbs.

Restart is accomplished by using a solid-propellant charge to fire up the turbine pump. Solid propellant also provides the small kick necessary to solve the zero-weight problem of the fuel on restart in the satellite's gravity-free condition.

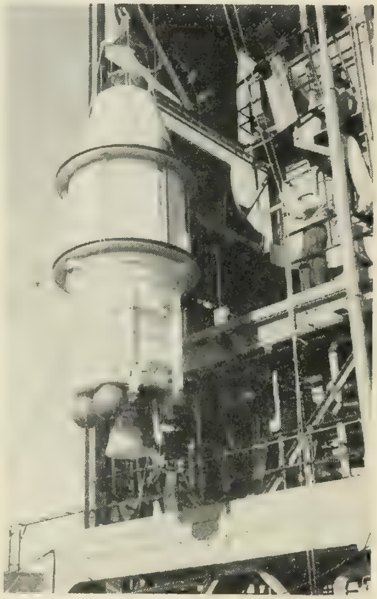
Engine gimballing is provided by an electro-hydraulic system. Attitude control is by compressed air jets.

Development test firing of the *Agena B* engine came as newsmen were admitted to the previously classified Lockheed facility for the first time.

Other highlights of the test base tour:

• Disclosure that Lockheed is carrying out research and development test work on a small liquid rocket engine of its own.

• Unveiling of a new "soft stand" used in *Polaris* firings to permit the missile to go through the motions of flight while securely tethered in the test stand.



LOCKHEED'S *Agena* vehicle is hoisted into place for test firing.

Willis Hawkins, assistant general manager of LMSD, said significance of the restart *Agena B* engine is twofold: it permits much heavier satellites to be placed in orbit and makes it possible to place them in higher-altitude, circular orbits.

This is how the restart engine is expected to work:

The *Atlas* booster drops off after burnout when the *Agena B* is near orbit altitude. The satellite continues to coast upward as it stabilizes itself to a horizontal position in reference to the earth's surface. This stabilization is not only to orient the satellite in relation to the earth but also to properly aim the propulsion system. This is accomplished by an infrared horizon scanner.

The engine then is fired for a period to bring the satellite to orbital speed, injecting it into orbit at the perigee. When apogee is reached, a timer restarts the engine to change the original elliptical orbit to a high-altitude near-circular orbit.

Restart can either be programmed or on ground command.

• **Beginning of *Midas***—Initial test of the *Atlas-Agena B* combination at Cape Canaveral is, in fact, the first of the Project *Midas* series.

The restart engine is of considerable significance to both the *Midas* and *Samos* programs, which are based on the work being carried out in the *Discoverer* series for the Air Force. Little has been said about these programs but they are known to have both defensive and offensive capabilities.

At a press briefing during the Lockheed-Air Force tour, Lt. Gen. Bernard A. Schriever, chief of the Air Research and Development Command, said the *Discoverer* series, which he called a "testbed" program, has been aimed at control and stabilization of specific payloads in a specific orbit.

Commenting on *Midas* and *Samos*, Gen. Schriever said military checkmate now can be achieved by exploiting advantages that were less important in past military history.

"One," he said, "is military intelligence." He described *Midas* as a warning system operating in the same regions of space as intercontinental ballistic missiles to give rapid notice, by immediate infrared detection of hot exhausts, of ICBM launchings.

Of *Samos*, he would say only that it was a surveillance satellite; he was obviously reluctant to be drawn out on other potentialities of the program.

• **Stressing urgency**—Gen. Schriever said development of these space systems must be pushed with the same urgency as the ICBM programs. He said consideration is being given to stepping up the *Midas* program, although it will remain in a research and development stage for some time. He said *Samos* is "adequately" funded at the moment.

The ARDC commander pointed out that while the Army has mission responsibility for defense against mis-

siles, the Air Force has the responsibility for early warning against ICBM's.

He did not comment on any Air Force interest in missile defense.

Midas definitely can use the restart technique of the *Agena B* in achieving circular orbit, assistant general manager Hawkins told the press.

• **Success revealed**—The engine fired at the Jan. 27 demonstration was undergoing its seventh firing in the development program. Restart was not demonstrated. But it was disclosed that the *Agena B* has been successfully restarted numerous times under near-vacuum conditions at the Arnold Engineering Development Center at Tullahoma, Tenn.

The firing was one scheduled in the normal test program, with an induced malfunction programmed into the firing. This was achieved by closing a valve in the propellant feed system. Despite this, the engine was expected to achieve a full duration firing of more than 240 sec. Shutdown came at 163 sec., however, when a small fire broke out in the engine area. It was quickly blanketed with carbon dioxide and damage was minor.

The firing was on one of three test stands in the sprawling Santa Cruz test facility. Two are Air Force stands being used for development and acceptance testing in the *Discoverer* satellite series, and the third is for captive testing of the Navy's *Polaris* missile.

The Lockheed-designed "soft stand" used in *Polaris* firings is equipped with four large steel struts or mounts which lock onto a steel collar around the middle of the missile being tested. These are anchored at the lower ends to hydraulically-operated assemblies similar to aircraft oleo structs.

• **Freedom of movement**—This arrangement permits the missile to move during the firing, allowing movement longitudinally and laterally as well as angular motion in pitch and yaw.

There is enough play to allow checkout of the control system within plus or minus 5-deg. of movement. This means the rear of the missile could move as much as a foot or a foot and a half during captive firing.

Movement is sufficient to produce vital data on missile dynamics which otherwise could not be obtained except on launch. Data recorded during runs on the stand has been proven out against data obtained during actual flight tests on the Atlantic Missile Range.

The system permits taking out of light-off shock as well as monitoring of guidance system responses more easily. Degree of restraint can be modified during a firing to simulate a complete trajectory.

As the missile gets lighter and center of gravity shifts, restraint can be lightened. Electronic signals to simulate, say, a crosswind buffeting, can be fed into the circuit to check control system reaction.

"Failure of the flight control system to correct the error during a test stand run merely results in a squibbly tracing on an oscillograph," a Lockheed engineer points out. "The same failure during an actual launch would mean loss of the vehicle."

• **Vast facilities**—Missiles and satellites are shipped to the Santa Cruz test facility from the production plant at LMSD's Sunnyvale headquarters, 50 miles distant. Modification and initial checkout are accomplished at Sunnyvale.

Components testing and captive firing then are conducted at the Santa Cruz test base before the vehicles are shipped to their destinations.

Company spokesman declined comment on the firing of a small liquid rocket engine, which newsmen witnessed in the component test area, other than to say it was "development test work" on a Lockheed engine. One source suggested it might be a scale-model engine.

Facilities at the test site include administrative, engineering, assembly and shop areas together with the two test stand complexes, all totaling some 85,500 square feet.

The Navy *Polaris* area has one test stand and one blockhouse while the Air Force satellite area at the moment has two stands and a common blockhouse and components test laboratory. A second blockhouse is under construction.

There also is a pyrotechnics test area for testing explosive bolts and separation devices.

Since April, 1958, there have been some 75 firings on the satellite program alone. It was estimated that 15 million data-seconds have been taken since October, 1958. There have been 136 cold flow tests on the program as well as 50 ground support equipment tests.

A 250-acre lake, well-stocked with trout, provides the main water supply for the base, which is spread over the heavily-wooded 4000-acre site 90 miles southwest of San Francisco.

The test base employs some 500 engineers, technicians and administrative personnel.

Mercury Drop Tests Are Nearing End

High reliability has been established; drogue chute has been reinstated in program which now has 44 drops scheduled and has perfect record to date

SALTON SEA, CALIF.—Testing of the *Mercury* capsule landing system is due to end later this month, with completion of the 44 drop tests now scheduled. Tests to date have been 100% successful.

The program includes low- and high-altitude drops, simulated aborts, deliberate attempts to foil the system, and at least one unplanned parachute abort which was successfully countered by the reserve system.

Radioplane, a division of Northrop, is under contract to McDonnell Aircraft for the landing system of the manned capsule in the National Aeronautics and Space Administration's *Mercury* program.

• **Simple and reliable**—Consisting of parachutes, chaff package for radar reflection, sofar bomb, and other recovery aids, the system is designed for simplicity, with a view toward complete reliability. At one point, the drogue parachute was eliminated from the program. This chute stabilizes the capsule after initial re-entry, and plans called for use of the roll jets on the capsule to serve this purpose.

But the chute has since been reinstated, and is expected to remain in the program.

In its 35th test drop, the capsule had a simulated abort, assuming the main parachute had torn free after partial inflation, leaving the capsule in free fall. The reserve system is actuated by a force-sensing device, which determines that lack of a load on the parachute risers indicates malfunction.

The astronaut in the capsule has the option of employing the reserve

parachute system if the automatic force-sensing device does not do so. This decision will undoubtedly be determined by the rate-of-descent instrument in the astronaut's compartment.

Housed in two separate compartments, the parachutes can be deployed independently of each other. If the main parachute should malfunction by failing to leave its compartment, the reserve chute would not be blocked but could deploy independently.

Deployment of the drogue chute is accomplished by use of a mortar.

In sequence, the 35th drop test, which simulated an abort of the main chute, was as follows:

• Capsule, 2160 pounds, and sled launched from 31,100 feet by C-130.

• Sled separation from capsule. (Sled is for handling ease in aircraft only.) T plus two seconds.

• Sled parachute deployment. T plus four seconds.

• Capsule drogue parachute deployment. T plus six seconds.

• Antenna fairing ejects, extracting main ringsail parachute at 10,000 feet. Sofar bomb ejection. T plus 77 seconds.

• Main ringsail parachute inflates. When load on chute reaches 1800 pounds, it is disconnected in simulated abort. T plus 80 seconds.

• Pilot parachute deployment to initiate extraction of reserve parachute. T plus 88 seconds. Altitude 7800 feet.

• Water impact at 30 f.p.s., reserve parachute disconnected by explosive charge. T plus 348 seconds.

Impact force of the capsule is approximately eight or nine g, with slight variations possible due to the impact angle. On a number of occasions, Radioplane personnel have tried to foil the landing system by tumbling the capsule upon its ejection from the aircraft. These have been countered successfully each time.

DROP OF *Mercury* capsule in Salton Sea tested Radioplane landing system.

Beginning in August, 1959, Radioplane has dropped "boilerplate" versions of the capsule from altitudes ranging from 2500 to 31,000 feet. There have been no unsuccessful tests. The 44 tests scheduled do not include those from Wallops Island or Cape Canaveral, merely those at Salton Sea Test Range in southern California.

• **Dimensions**—The capsule measures 10 feet high, with a six-foot base diameter and 26-inch neck. A revision over the early configuration places the exit hatch at the narrow end of the capsule, rather than near the base. This prevents the exit hatch from being covered with water in an ocean-recovery operation. Consideration is also being given to adding flotation bags around the capsule on water entry, to eliminate the danger of a capsize of the capsule.

Ground support services in the drop test program have been supplied by the Naval Parachute Facility at El Centro. This includes photo instrumentation, documentation coordination, flight test aircraft and crew support.

AF Space Center Now Operational

ARDC's 6549th Test Wing takes over satellite center. Move is considered a big step in Air Force becoming U.S. Space Force

SUNNYVALE, CALIF.—The U.S. Air Force took a big step toward becoming the U.S. Space Force last week with the announcement that its new satellite center here had taken over control of Project *Discoverer*.

For the first time, launch, tracking, acquisition and recovery phases of a satellite program are under one military headquarters.

This is the 6549th Test Wing (Satellite) of the Air Research and Development Command—which is, in fact, the first space wing of the Air Force.

"With the development of a working military satellite system—the end product of the *Discoverer* series—operation of the system in the Satellite Test Center will be a responsibility of the Deputy Commander for Space Systems Operations," an Air Force announcement said.

• **Far-flung system**—Project *Discoverer* currently is under the Deputy Commander for Systems Development Test, who runs the streamlined space center.

The space wing also includes a launch squadron at Vandenberg AFB and tracking squadrons at Vandenberg, New Boston, N.H., and Kaena Point, Hawaii. A recovery control group at Hickam AFB, Hawaii, operates the Hawaiian Control Center.

Heart of the space wing is the new Satellite Control Room, the command post which is headquarters for command surveillance and direction during launch, orbital and recovery activities. *Discoverer IX* is the first assignment.

• **'For a new age'**—The $1.2-million building in which the control room is housed was dedicated on Jan. 28 by Lt. Gen. Bernard A. Schriever, ARDC commander. Known as the Satellite Test Center, it also contains administrative, planning, operational and communications offices covering more than an acre.

Gen. Schriever called it "a new facility for a new age."

He said it will play an ever bigger role in handling the growing network of space programs, including the forthcoming Project *Midas* and Project *Samos* satellites.

Operation of the center now is a joint responsibility of the 6594th wing and the Lockheed Missiles and Space Division, prime contractor and systems manager for *Discoverer*.

The center is located adjacent to LMSD facilities on land donated by Lockheed. Construction now under way will add another 46,000 sq. ft. and bring total cost of the sprawling center and its equipment to $2.2-million. This figure does not include the $1.5-million worldwide communication system.

• **Controlling new generation**—The expansion will provide what personnel at the center call a "third-generation" control room to handle additional satellites. The *Discoverer* program first was monitored from the now-defunct Development Control Center in Lockheed's Palo Alto scientific research laboratory.

During launch, orbital and recovery activities in the *Discoverer* series, both Air Force and Lockheed personnel man the six consoles in the control room. From here, they direct and coordinate activities at the launch site, four tracking stations and in the Hawaiian Control Center. The HCC controls a tracking station, the C-119 recovery aircraft squadron, and a RC-121 radar aircraft.

Tracking and acquisition are carried out by the stations by Vandenberg, Point Mugu, Kodiak, and Kaena Point, and by two Navy telemetry ships, one stationed between Alaska and Hawaii and the other off the Lower California coast.

Data reduction is done at Vanderberg and the LMSD and scientific research laboratory although the Satellite Test Center later will be equipped for this purpose.

• **Who mans consoles**—Within the Satellite Control Room the tests are under the direction of Air Force test controller Lt. Col. Charles G. Mathison and Lockheed Test Director Stanley K. Hutchin, who are stationed at two upper consoles.

Four lower consoles are occupied by two Air Force Assistant Test Controllers and two Lockheed Assistant Test Directors. These men make the standard decisions and give the routine orders; command decisions are made by the Test Controller and Test Director. Seventh member of the team is a communications officer seated at a desk between the two upper consoles.

Each console constains a closed-circuit TV screen, a push-button communications panel, and a speaker-receiver headset.

The TV screens survey both satellite and ejection capsule plotting boards and incoming teletype messages. The communications panel provides push-button selection of voice lines to all stations. The communications officer also controls a central assignment panel which can established any combination of voice lines to any or all consoles.

• **Links with outside**—Three large Vu-Graph screens faced by the consoles keep the control team posted on current weather conditions at all stations, as well as maps, plots and other information flashed from the adjacent program information center (PIC).

Above these screens are clocks indicating local time at all stations, an elapsed-time indicator and a synchronized electronic system time indicator. This is a digital clock which is recycled at midnight Greenwich time each day.

Lighting in the control room is variable and can be cut as low as five candlepower to reduce eye strain during long vigils.

Voice lines are available to all tracking stations, to Vandenberg and to Cape Canaveral. The link with the Air Force Ballistic Missile Division's space activities status center in Los Angeles is provided by an Engineered Military Circuit (EMC).

The satellite center also is connected with all tracking stations by 60-word teletype and 100-word-per-minute data teletypes. Four transmitting teletypes in the communications center include two with "secure on line" capability to handle classified messages, and one commercial TWX machine. Teletypes also provide back-up communication when voice circuits fade. Every voice line can be switched to the 100-word teletype to bring in information from the tracking stations, thus avoiding the cost of dual lines.

The control room also is linked with the computer and data reduction centers. Two Remington Rand 1103A digital computers are employed here.

Two tape recorders, controlled remotely from the lower consoles, record all hot-line conversations.

The satellite center does not at any time have direct contact with or control over satellites, but makes and transmits the command decisions concerning them.

The operation, as outlined by Lt. Col. Mathison, covers five phases:

• Pre-launch. Coordination of all activities and preparation, including simulation of launch injection into orbit and satellite tracking.

• Launch. During this phase, launch responsibility is passed to the Vandenberg blockhouse while Vandenberg, Pt. Mugu and the down-range ship provide exit data which is passed along to the other stations so they can anticipate the where and when of acquisition.

• Orbital. Tracking stations acquire and feed back the volumes of data from the satellite.

• Recovery. Recovery area is pinpointed and forces positioned. Recovery is controlled through the Hawaiian Control Center.

• Post-orbital. Collection and evaluation of all data.

Contract for the system in the third-generation control center now under construction was awarded to the Space Communications Division of Radiation, Inc., located at nearby Mountain View. The present center can handle only two satellites at a time and also is being used for developing and evaluating equipment and techniques.

The new center will have a considerably expanded capability. In general, it will handle more orbits, more data and will permit more commands. Computers with considerably increased capacity will be employed as the programs become more sophisticated and more automatic equipment, including an automatic plotting board, will be used.

THESE CONTROLLERS are in contact with launch site, four tracking stations, and the Hawaiian Control Center, all part of the new satellite center.

U.K. Firms May Be Tougher Rivals for U.S.

LONDON—The recent reorganization-by-merger of the British aircraft/-missile industry is likely to mean tougher competition for Britain's chief rival in overseas markets—U.S. manufacturers.

The consolidation into two main groups—carried out at the "suggestion" of the British government—has so far been achieved only on paper. Now comes the extremely difficult and painful task of carrying out its aims—elimination or reduction of the duplication of effort and dissipation of resources on too many projects, that have been the industry's major postwar weaknesses.

Competition between the two groups—Hawker Siddeley-de Havilland and English Electric-Vickers—is likely to be encouraged by the government, but observers here believe it would be a mistake for them to fight for overseas markets. They feel it would be far better for them to work together to combat American competition.

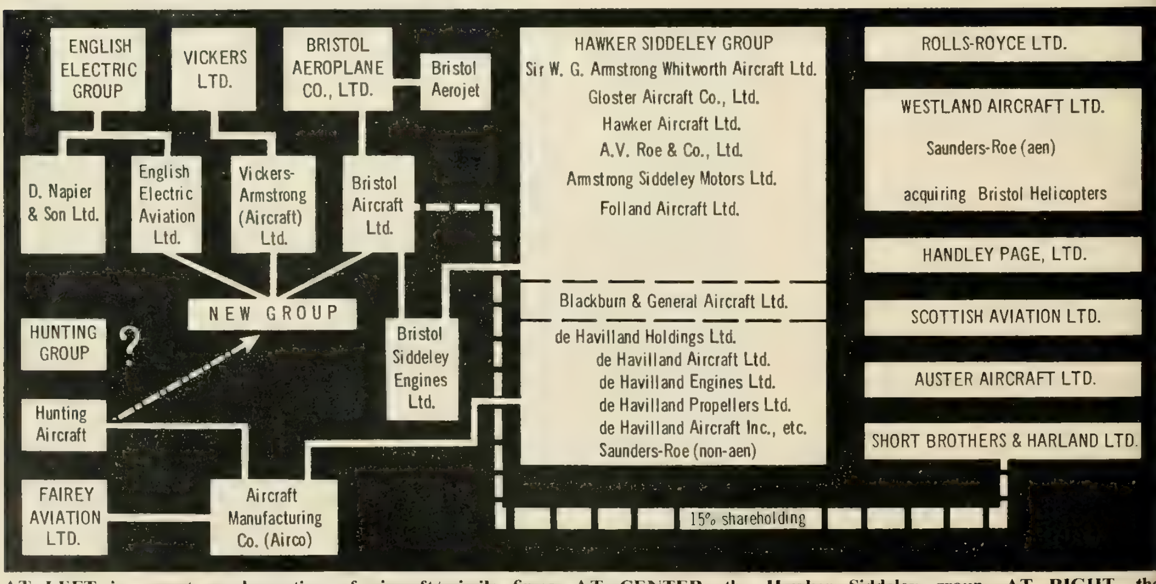
• **Second shoe falls**—The Hawker Siddeley/Folland Aircraft/Blackburn/-de Havilland merger was followed by another major amalgamation, when the three largest remaining individual firms (Vickers Ltd., English Electric and Bristol Aeroplane Co.) decided to merge their guided weapon/aircraft interests in a new company, not yet named. The shares of this will be held in the proportions 40, 40 and 20% respectively; there will be no issue of share capital but an agreed financial adjustment. This new company will have three wholly-owned subsidiaries: Vickers-Armstrongs (Aircraft) Ltd., English Electric Aviation, and Bristol Aircraft.

All three of the parent bodies have interests outside the missile/aircraft field, and will retain their independence in these respects. Some activities will be disposed of—thus Bristol is selling its helicopter interests to Westland Aircraft (who recently acquired Saunders-Roe).

• **Rest of the industry's future**—Apart from these two big combines, only a few firms remain, and pressure from the Minister of Aviation is likely to cause these to disappear soon. Hunting Aircraft will probably go into the new Vickers group, Fairey Aviation will be acquired by Westland, leaving only Handley Page (likely to remain independent as long as Sir Frederick Handley Page is still alive and in control) and Short Brothers & Harlands (whose position is complicated by a large Government shareholding and the unemployment problems of Northern Ireland).

As regards the groups (Hawker Siddeley, Vickers and Westland), these are already interconnected through holdings in various subsidiaries, so further rationalization may follow. The Minister of Aviation, Duncan Sandys, is believed to favour the concentration of the industry into only two groups, and this has nearly been achieved. With so many changes in the past few weeks, it would be only a small step for all the groups to combine in a single organization, but this would be unlikely to receive the Minister's approval. Nor would it find favour with the Labour opposition—despite their policy of nationalization, such an arrangement would have all drawbacks of a monopoly without the "virtue" of state ownership, and employees would find it very difficult to change their jobs.

Britain's New Missile/Space Line-Up



AT LEFT is newest amalgamation of aircraft/missile firms. AT CENTER, the Hawker Siddeley group. AT RIGHT, the dwindling list of independents. The lines indicate some interconnections and likelihood Hunting will join the new group.

Japanese Forces to Be Missile-armed in 5 Years

by Kazuo Takita

TOKYO—The three arms of Japan's self-defense forces will be equipped with guided missiles by the end of Fiscal Year 1965.

This is envisaged in Japan's projected second five-year defense build-up program, which will go into effect in 1961.

Prime Minister Nobusuke Kishi is believed to have discussed the draft of the program with U.S. defense officials when he visited Washington recently as head of a Japanese delegation to sign the newly revised Japan-U.S. Security Treaty on Jan. 19.

According to an official announcement by the Japanese Defense Agency on Jan. 16, the surface-to-air *Tartar* missile will be installed on a 2600-ton destroyer to be built in FY 1961.

The Convair *Tartar* will be purchased from the U.S. for $5,833,333 on a three-year installment basis, under the MSMS (Mutual Security Military Sales) aid program. The official contract is expected to be signed in late March.

Construction of the missile destroyer, to be completed in 1963, is part of Japan's self-defense reinforcement project for 1960, revealed by the Defense Agency on Jan. 16.

The reinforcement program, based on a defense appropriation of $41,-250,000, is centered on a $2,500,000 missile development plan to buy 60 Philco/GE *Sidewinders* from the U.S., and to send a 45-man Ground Self-Defense Force team to train with Western Electric *Nike-Ajax* at Fort Bliss, Tex.

The Air Self-Defense Force will shortly begin maneuvers with *Sidewinder* air-to-air missiles at Gifu, attached to F-86D and F-86F jets.

Plans are under study to create four ground-to-air Boeing *Bomarc* missile corps and assign them to Yokohama; Hokkaido, northernmost island of Japan; and Kyushu, southernmost island, by the end of FY 1960.

Four *Nike-Ajax* battalions will be organized in the Tokyo-Yokohama area; Nagoya; Kobe-Osaka area; and Shimonoseki in Yamaguchi Prefecture; two Raytheon *Hawk* battalions in the Tokyo-Yokohama area, and four *Nike-Hercules* battalions in key cities in Japan proper.

Eight to 12 antitank missile companies will be stationed in Hokkaido and various other places by the end of FY 1961. Defense Agency officials are studying a plan to import 600 antitank missiles annually from France.

west coast industry . . .

By FRANK G. McGUIRE

Frustrated attempts to get a readable signal through excessive static are by no means limited to the electronics brotherhood. There is a similar problem in getting a simple answer—based on hard engineering facts—from organizations with an axe to grind. We recently had occasion to try rounding up as many facts as possible on the state of the *Atlas* and *Titan* programs. We contacted as many people and organizations connected with these two massive projects as possible, to avoid getting an unbalanced picture.

Consider the situation which arose when we asked a simple question. Question—"Can *Atlas* be launched from a *Titan* silo or vice versa?" Answer from the *Atlas* camp: "Yes, but not vice versa." Answer from the *Titan* camp: "No, but the reverse is true." Answer from a third party familiar with both systems: "Neither can be launched from the other's equipment."

The objective of this kind of thing? Simply to make one's own product seem more versatile, and therefore better, than the competition's. The middle path—which we hope represented as clear a signal as possible—was spelled out in last week's M/R. But we do wish industry wouldn't present such a static-ridden signal to the press and public. It only aggravates the difficulty in getting industry's story across to Congress and John Q. Taxpayer.

Marquardt Corp. has established . . .

a Facilities Engineering Division to provide architectural and engineering services to government and commercial enterprises. The new organzation will plan, design and construct space environmental laboratories, launching complexes, and test facilities. Leigh E. Dunn is director of the new group, and will continue as director of the Test Division.

Experience of the Facilities Engineering Division includes design, project direction and construction of the Air Force/Marquardt jet laboratories in Van Nuys and Ogden. Another project was the Tory II reactor research test facility at AEC's Nevada Test Site at Jackass Flats.

Electro-Optical Systems has sold . . .

a minority portion of its stock to the Aerojet-General Corp. EOS, winner of the contract for development of an ion engine for the Air Force (M/R, Feb. 1, p. 24), has been active in plasma propulsion systems, solar energy conversion, advanced power systems, solid state physics, advanced electronics and space defense systems. The new capital will be used to broaden the company's R&D base, as well as to develop proprietary items.

Lockheed's Employe-Benefit Program . . .

costs the company 87¢ per employe-hour. For every dollar spent in 1945, the firm paid out $1.58 in 1952, and $3.69 in 1959. The benefits work out to an average of $1800 per year per employe.

Fuss about Vandenberg/PMR relations . . .

often overlooks the routine cooperation that is part of the everyday job. Tri-service cooperation was demonstrated recently when a school near VAFB wanted an F-86. AF couldn't assign a helicopter to the airlift job, but called on Navy for help. Navy assigned a Marine 'copter to the mission, and the school got its Saberjet from Air Force, via Marine helicopter which was assigned by Navy.

San Diego's efforts to reduce dependence . . .

on defense procurement have gotten underway with establishment of a five-year program to diversify industry. The close of the 1950's saw the Southern California city listed as the fourth largest metropolitan area in the eleven western states. Military payrolls dump $1 million daily into the economy. The drive is paralleled in Los Angeles, which has similar diversification plans.

DuPont's 'Teflon' 100 Now Available

Du Pont is commercially producing a new plastic, "Teflon" 100, the company has announced. It is expected to find wide markets in the electronics and chemical processing industries.

Known as an FEP-fluorocarbon resin, the new material can be extruded or molded in the thermoplastic processing equipment. It was developed as a supplement to Du Pont's present line of "Teflon" TFE-fluorocarbon resins, which must be processed in a manner similar to powdered metals.

Like the TFE resins, "Teflon" 100 is virtually immune to chemical attack, has excellent electrical insulating, anti-stick, and frictional characteristics, and will not absorb moisture. "Teflon" 100 differs somewhat from the TFE resins in heat resistance. TFE resins are rated for continuous service at temperatures up to 500°F and at higher temperatures for more limited periods of time. The usual continuous service ceiling for "Teflon" 100 FEP resin is about 100°F lower. Both materials resist extreme cold—down to —450°F.

Robert A. Kellar of Du Pont's Polychemicals Department described the new product as a "major technical breakthrough" resulting from 15 years of research studies. He said Du Pont spent $19 million for research, development, and operating costs during the eight-year period prior to the start-up of a commercial plant for "Teflon" 100 at Parkersburg, W.Va.

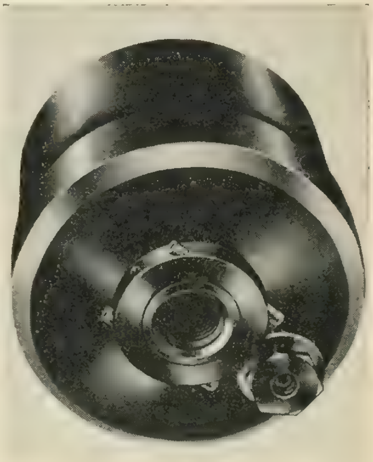
Price of the new resin is $11.60 a pound in truck-load quantities. Prior to commercial production, small quantities from a pilot plant were provided to about 150 interested firms at a price of $19 a pound.

Specific uses for "Teflon" 100 FEP-fluorocarbon resin cited by Kellar include jackets for coaxial and multi-conductor cable, aircraft wiring, molded electronic components, laboratory tubing, and chemical equipment linings.

He noted that these FEP resin applications will greatly expand the market areas served by "Teflon" fluorocarbon resins. The older TFE resins are widely used for electrical insulation, chemical-resistant hose, and lined pipe, bearings, seals, piston rings, packings and gaskets. Introduction of "Teflon" 100 FEP resin is expected to accelerate the development of uses which were not practical with TFE resins because of processing difficulties.

Du Pont's Film Department is marketing films made from "Teflon" 100. Coil-wound devices, capacitors, and printed wiring and circuitry are viewed as promising uses for the film.

Circle No. 225 on Subscriber Service Card.



Pressure Regulator Has Space Applications

An oxygen pressure regulator has been designed and developed by Airaterra, and is available for immediate application.

It is suited for use in conjunction with space capsule atmosphere-purging regulators, or to supply constant pressure to oxygen breathing demand regulators.

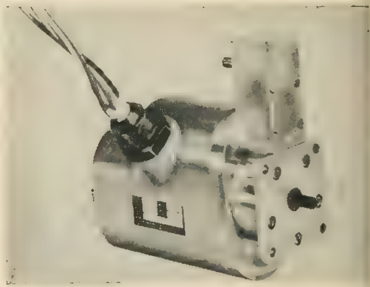
It weighs only 11½ ounces, and is 2¾ in. long with a diameter of 2½ in. Its psi ranges are 100 plus or minus 10 outlet, and 100 to 10,000 inlet.

The aluminum oxygen pressure regulator is piston type for high reliability. It is single-stage and has a metal-to-metal throttling seat. Also of great importance is its zero leakage lock-up capability.

Circle No. 226 on Subscriber Service Card.

Immersible Valve Actuator Develops 100 in. lb. Torque

A new small motor-driven actuator designed for operating a ball valve submerged in gasoline develops 100 in. lb. of starting torque, with a nominal



running torque of 25 in. lb. The unit is housed in a cast aluminum alloy case designed to withstand 20 psi. pressure without leaking.

A special optional feature is a manual over-ride device which permits operation of the actuator with a wrench in the event of power failure. The actuator shaft rotates 90° ± 1½° and incorporates a Geneva movement to insure accurate valve positioning with excellent repeatability. This particular version operates on 115 vac, 400 cps power.

The actuator weighs 2.6 lbs., is 5" long, and fits in a 3" square envelope. It exceeds appropriate MIL specifications. Various modifications may be made to suit the actuator to similar applications.

Circle No. 227 on Subscriber Service Card.

High-Current Switching Diode Claimed Fastest

What has proved to be the fastest high-current silicon switching diode for computers is now in volume production at Sperry Semiconductor Division of Sperry Rand Corp.

Labelled "the 1N920-1N923 series," this newest advance in high-conduction, fast-recovery diodes has met the most severe requirements of high-current pulse circuits for computer switching, pulse clamping, gating, blocking and diode logic circuits. These 0.3 microsecond, ½-ampere devices are available immediately in quantity, and set new standards wherever advanced performance characteristics are required.

Selections from this line have been used widely in the Univac Larc computer, recently announced by Remington Rand, which operates at very high speeds, 25 to 200 times faster than other existing commercial computers. Thousands of these Sperry diodes are built into the Larc's critical memory driving circuits.

In addition to the UNIVAC Larc

application, Sperry diodes in this series have found wide acceptance by the industry in more than a dozen other high-speed computer prototypes.

The new diodes are said to approach a "universal", "all-purpose" diode—excellent for general high-conduction applications as well as for the more exacting computer uses. Available in four voltages, they effect 0.3 usecond switching of ½-ampere pulses with a peak power dissipation of 800 milliwatts. Designed for high-temperature operation (to 175°C), the 1N920 series features high forward conductance (500_mA at 1 volt maximum drop) and low leakage (50_uA maximum at 150°C).

All units feature a maximum recovery time of 0.3 microseconds to return to 10K ohms when switched from a forward current 2 microsecond pulse of 500_mA to a reverse voltage of –50 volts (–30 V for 1N920), with a loop impedance of 1K ohms. Faster switching speeds are obtained at lower currents.

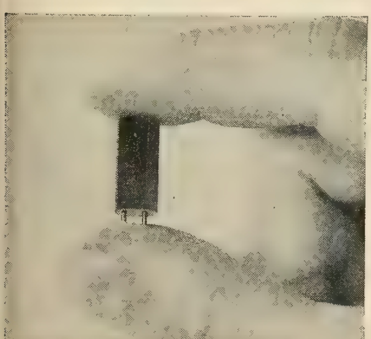
Circle No. 228 on Subscriber Service Card.

Tiny Unit Protects Motors From Heating

Development of the smallest inherent overtemperature protector, the Klixon 5891, is announced by the Spencer Products group of Texas Instruments Incorporated, Metals and Controls Division. Designed specifically for sub-fractional hp motors 1" in diameter and larger, the device is equally suitable for small solenoids and transformers.

The protector maximizes system reliability by preventing permanent interruption of equipment output, and by safeguarding against excessive temperatures that damage or destroy system components.

Responsive to both current and temperature, the protector is designed



with a compensating heating element to ensure that the snap-acting, disc-type sensing element will follow closely the temperature changes of the component to be controlled. Temperature levels of protection are 150, 175, and 200°C. Maximum contact capacity is 5 amperes at 27 volts dc or 120 volts ac. The units conform to military specifications, MIL-M-7969 and MIL-M-8609, and when mounted in equipment they comply with MIL-E-5272.

To be most flexible in installation, the basic design of the Klixon 5891 has no flanges or mounting projections. The protector can be inserted into a cavity secured to the windings, or held by a clip. Envelope dimensions, 0.28 x 0.20 x 0.60", are kept to a minimum by using welded on leads to customer specifications. Weight, excluding leads, is 1 gram.

Circle No. 229 on Subscriber Service Card.

Missiles Now Charted On Heat-Sensitive Paper

A new heat-sensitive chart paper for recording in-flight performance of high-speed satellites and missiles employs heat rather than pressure for accurate markings. The paper was designed to produce faster, more legible permanent tracings of oscillographic signals.

Hycar latex, a product of B. F. Goodrich Chemical Co., in combination with carbon black, gives the paper a smooth flexible base onto which an extremely low-density top coating, high in air content, is applied. When heat is applied, the top coating becomes transparent—allowing the black base to show through. The composite structure is waterproof and prevents greying of the coating at high humidity. This maintains the background whiteness necessary for accurate readings.

Called "Heatrace" by its developer, the Nashua Corporation, Nashua, N.H., the chart paper is used by Minitrack stations around the world. Originally designed for electrocardiographs and other types of hot-stylus oscillographic recorders, Hycar-based recording paper has improved characteristics which offer advantages such as greater sensitivity to a heated stylus, improved durability, and more accurate and legible tracings—all invaluable to industrial and Space-Age instrumentation.

The paper's durability is of prime importance where extensive handling is required. In cardiograph recordings, for example, the records of the patient's heartbeat must be of the direct reading type and are subject to considerable handling in the course of their study as a diagnostic aid.

Heat-sensitive papers such as Nashua's "Heatrace" are being used more and more in diverse applications for recording the signals and events in connection with compilation of scientific data from complex electronically controlled systems says Goodrich.

Circle No. 230 on Subscriber Service Card.

Silicon Mesa Transistor Line Now Available

Hoffman Electronics Corporation announced today it is now in production on two newly-developed silicon mesa transistors that outperform similar-type devices now on the market.

Because of design features, resulting in unusually high small signal current gain, either of the devices will replace up to three transistors of the same classification in many circuit applications, G. William DeSousa, vice-president marketing of Hoffman's Semiconductor Division, said.

The new diffused junction, drift field mesa transistors (JEDEC No.'s 2N696 and 2N697) are designed for use as high speed switching units operating at medium power levels and as very high frequency amplifiers.

The NPN type devices are the first to be introduced in a new family of silicon transistors now being developed at Hoffman, DeSousa said.

Hoffman's U-shaped base-emitter configuration allows for the first time utilization of virtually all the transistor's emitter area. The minimum high

frequency gain at high currents is 6 or more at 29 megacycles, nearly three times the 2.5 gain of comparable units. This higher gain, he said, is due to tighter control of the base width in fabrication.

This design, coupled with an exclusive photographic fabrication technique, also has lifted current and frequency characteristics of the new device above industry specifications.

The new transistors are capable of useful current gains at 40 megacycles, indicating efficient operation in the ultra high-frequency band when operated in a grounded base configuration.

The photographic technique devel-

oped by Hoffman, used in fabrication instead of conventional mechanical methods, gives greater precision of geometric control and results in better and exceptionally uniform characteristics.

The new transistors, with their high current gain and operating frequencies, were designed particularly for military applications such as computers, radar and data processing equipment for missiles. Commercial applications include small signal amplifiers, high speed switching devices for computers, data processing equipment and video amplifiers.

Both transistors are basically control devices for small to large signal switching amplification. The only difference between the two is a higher DC pulse current gain in the 2N697. This measures a minimum of 40 and a maximum of 120 compared to a minimum of 20 and a maximum of 60 in the 2N696.

The company's quality and reliability standards require pre-aging the transistors at 300°C before hermetically sealing them in a controlled inert gas atmosphere to stabilize the electrical parameters.

Total power dissipation of the two transistors is two watts at 25°C case temperature.

The transistors have a maximum collector-base voltage of 60V, collector-emitter voltage of 40V and an emitter-base voltage of 5V.

In saturation, with a base current of 15 milliamperes and a collector current of 150 milliamperes, the emitter-base voltage is less than 1.3V and the collector-emitter voltage is less than 1.5V.

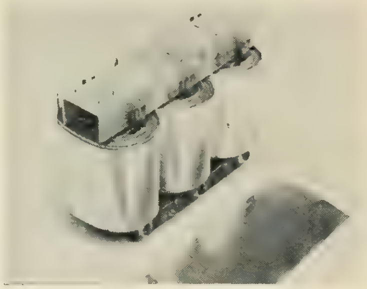
Circle No. 231 on Subscriber Service Card.

Aluminum Coated Wire Operates at 1900°F

Flexible aluminum-oxide-insulated strip and wire good for temperatures as high as 1100°F and, in certain forms, as high as 1900°F, is now available from Permaluster, Inc.

The anodized wire or strip in all gages and sizes is made by the same Permaluster continuous anodizing process already successfully applied to high-temperature wire for the aircraft/missile and electronic industries. This process provides a coating highly flexible and capable of withstanding a great deal of deformation without fracturing or crazing the film.

With its melting point of 3800°F, aluminum oxide provides excellent protection to permit using metal strips in



such units as transformers without cooling. The film thickness can be carefully controlled from as low as 0.00008" to 0.001". Aluminum-oxide-insulated aluminum strips can now be used in large or small electronic units to give both savings in space and weight reductions of up to 50% compared to conventional materials.

The flexible aluminum oxide insulation can also be applied to other metals. One example is nickel-plated copper strip or wire (nickel plate is needed to eliminate galvanic action and diffusion in high-temperature operation). It can also be used on silver for applications close to the approximate 1900°F melting point of the bare conductor.

Circle No. 232 on Subscriber Service Card.

150 lb. Vibration Fatigue Tester Modified

Two versions of an improved Vibration Fatigue Testing Machine, in which a vertical table movement is controlled entirely by a piston operated mechanism, have been announced by All American Tool & Mfg. Co. They are Models 150 VP-D and 150 VP-T. Table load capacity is 150 lbs. at 10 g's of acceleration. For g values higher than 10 the load must be reduced. Maximum capacity is approximately 23 g. Vibration is produced in simple harmonic motion.

Acceleration and deceleration are regulated by the Range Selectro, an automatic frequency control device. On Model 150 VP-D, starting at 10 cycles per second, frequency may be increased uniformly to 60 cps (600 to 3600 vibrations per minute). On Model 150 VP-T the available range is

from 5 to 100 cps (300 to 6000 vibrations per minute). Any range of frequencies within this total range may be used, such as 15 up to 45 cps and back. Range Selector can be cut out and frequencies held at any desired point within the available range. Frequencies can also be changed manually.

Circle No. 233 on Subscriber Service Card.

Automatic Welding Wires Are Now Available

Air Reduction Sales Co. is now marketing automatic welding wires for use with the submerged arc welding processes. Alloys in this line are made from selected heats of steel, with analysis carefully controlled to fuse with the parent metal under automatic welding conditions and give comparable physical and chemical characteristics across the base metal, the affected zone and the weld metal.

Welding wires offered are low-carbon, general mild steel, high tensile steel, highest tensile steel, mild steel killed, general tensile and medium carbon steel. Wires are available in coils. Each coil is carefully thread-wound to facilitate unwinding, and a constant controlled tension is maintained during coiling to assure a neat coil that will support itself and keep its designed shape and dimensions.

Coils are available in weights of 25/30 lbs., 55/65 lbs., 75/100 lbs., 120 or 180 lbs.; or in fibreboard drums of 250, 500, or 750 lbs. for interrupted production welding.

Circle No. 234 on Subscriber Service Card.

Accelerometer Provides Wide Sensitivity Range

Wide application in telemetry and vibration work is forecast for a new high-sensitivity MV 300 accelerometer developed by de Havilland Propellers, Ltd.

The instrument has a full-scale output of 25V, and models are available with sensitivities ranging from 0.5V to 8V per g when working into a 0.5 megohm load, with natural frequencies from 137 to 34 c/sec. It is intended for use between −60°C and +100°C, and has a maximum zero error of 1.5% of full scale and a maximum temperature coefficient of 2.5 mV/°C. The moving element is the laminated armature of a differential transformer pickoff. Stops capable of withstanding shock loads and overloads of about 100 g are fitted, and external adjustment is provided for zero error and sensitivity. The damping medium is silicone oil.

Circle No. 235 on Subscriber Service Card.

New Literature

PRIMARY BATTERIES. A technical bulleting, "The Yardney PM Silvercel aBttery, a re-usable primary!", has just been issued by Yardney Electric Corp. It describes a new silver-zinc battery system, which combines the features of both primary and secondary batery types, offering the highest energy output yet achieved; fast manual activation (full power in 5-30 minutes, with no bulky activation mechanism); long activated stand time; and recyclability. The 6-page illustrated brochure on the PM Silvercel battery describes all electrical and physical characteristics; gives applications data; and compares performance with other battery systems through graphs and charts.

Circle No. 200 on Subscriber Service Card.

TITANIUM WELDING. The best methods for welding titanium piping and tubing by the gas tungsten-arc process are explained in a 24 page report published by the American Welding Society. A most complete description is given from an explanation of the welding process to the selection of electrode and filler metal. The contents of the report include: process, power supply, electrodes and filler metal; titanium grades, joint design and preparation, cleaning; gas shielding, welding techniques; heat treatment; and weld quality tests.

Circle No. 201 on Subscriber Service Card.

STEEL. A techincal bulletin on engineering and maintenance applications of a pre-hardened, machinable high strength steel, Viscount 44, has been prepared by Latrobe Steel Company. Viscount 44 is furnished pre-hardened at a hardness range of Rockwell C 42-46. It meets high strength requirements up to 200,000 psi without further heat treatment. Basically an AISI—SAE Type H-13 steel with a high vanadium content, plus carefully controlled and evenly dispersed alloy sulphides, the Latrobe product has achieved outstanding performance when used in a wide range of engineering and maintenance applications.

Circle No. 202 on Subscriber Service Card.

POWER CONNECTORS. A twelve-page catalog on Series 14, 16, EZ and GA Continental Connectors has just been released by the Electronic Sales Division of DeJur-Amsco Corporation. These four series are miniature rectangular power connectors designed for heavy duty applications in guided missiles, aircraft and electronic equipment requiring high dielectric and mechanical strength combined with high precision and reliability. Complete specifications, outline dimensions, illustrations and general information are covered in the technical catalog.

Circle No. 203 on Subscriber Service Card.

contracts

NASA

$252,210—**Electronic Associates, Inc.**, Long Branch, N.J., for an analog computer system.

MISCELLANEOUS

$1,500,000—**General Dynamics Corp.'s Electric Boat Div.**, for installation of an integrated electronic package on a missile tracking ship to be used on the Atlantic Missile Range.

$892,173—**Servomechanisms, Inc.**, Los Angeles, for true airspeed computers. Subcontract from **Douglas Aircraft Co.**

$444,000—**Potter Instrument Co.**, Plainview, N.Y., for high-speed printing equipment to be used in connection with a classified project.

NAVY

$2,050,000—**The Martin Co.**, Orlando, for follow-on production of transmitters for the *Bullpup*.

$520,000—**Raytheon Co.**, Waltham, Mass., for guidance components for the *Polaris*.

$54,586—**Feedback Controls, Inc.**, Natick, Mass., for data transmitters and receivers.

AIR FORCE

$688,000—**Aeronutronic Div., Ford Motor Co.**, Newport Beach, Calif., for designing an expanded tracking system for satellites.

$163,228—**The Marquardt Corp., Pomona Div.**, for design, fabrication and testing of test consoles for control unit in the *Minuteman*. Subcontract from **North American Aviation, Inc.'s Autonetics Div.**

$105,102—**North American Aviation, Inc.**, Downey, Calif., for repair of 131B weapon system.

$103,845—**Sterling Precision Corp.**, Port Washington, N.Y., for turntable gyro test.

$69,919—**New York University**, New York City, for research on theory of feedback communication systems.

$43,500—**University of Michigan**, Ann Arbor, for research directed toward study and analysis on the radiative properties of plasmas including the effects of heavy ions.

$39,831—**New York University**, New York City, for study of magneto-hydrodynamics with application to phenomena occurring in the vicinity of our planet and in space.

$22,000—**U.S. Transistor Corp.**, Syosset, N.Y., for germanium PNP alloy junction transistors.

ARMY

The Gabriel Co., Rocket Power/Talco Division, Mesa, Ariz., for development and delivery of booster rockets for launching reconnaissance drones. Amount not disclosed.

$82,599,690—**The Martin Co.**, Orlando, for continued research and development of the *Pershing* weapon system.

$3,300,000—**The Martin Co.**, Orlando, to provide publications and training for Missile Master maintenance personnel.

$9,779,887—**Raytheon Co.**, Andover, Mass., for repair parts for *Hawk* missile system. (Three contracts.)

$2,198,253—**California Institute of Technology, Pasadena**, for continued research and development on the *Sergeant* missile.

$1,932,728—**Chrysler Corp.**, Detroit, for *Jupiter* engineering services.

$899,600—**Chrysler Corp.**, for the *Jupiter* missile system.

$766,854—**Chaney & Hope**, Dallas, for construction of strategic missile facilities at Altus AFB.

$735,738—**Raytheon Co.**, Andover, Mass., for repair parts and replenishment repair parts for the *Hawk*. (Six contracts.)

$293,621—**Douglas Aircraft Co., Inc.**, Santa Monica, for launching area items. (Two contracts.)

$265,746—**Western Electric Co.**, Winston-Salem, N.C., for *Nike* spare parts and components.

$250,000—**Scientific-Atlanta, Inc.**, Atlanta, Georgia, for equipment to be used for field testing radar antennas.

$99,171—**Autometric Corp.**, New York City, for study of the lunar survey system.

$86,662—**Plasmadyne Corp.**, Santa Ana, Calif., for tunnel development.

$75,633—**Electro-Optical Systems, Inc.**, Pasadena, for the study, development and test of a microbaroswitch.

$70,000—**North American Aviation, Inc.**, Canoga Park, Calif., for rocket engines.

$69,062—**Sprague Electric Co.**, North Adams, Mass., for research and development work for 18 months to design and fabricate experimental and preliminary development models of stable ceramic capacitors.

$47,952—**North American Aviation, Inc.**, Downey, Calif., for digital computer.

$32,640—**Bomac Laboratories, Inc.**, Beverly, Mass., for electron tubes.

$30,000—**Johns Hopkins University**, Baltimore, for study of dielectrics for outer space.

M.I.T. Expands Materials Research with U.S. Grants

Several branches of science and technology will collaborate in extensive materials research at the Massachusetts Institute of Technology, under a pair of grants totalling $599,200 from the National Science Foundation.

The two-phase program will be directed by Dr. John C. Slater, Chief of M.I.T.'s new Laboratory of Chemical and Solid State Physics.

Under the first grant changes taking place at varying low temperatures in ferromagnetic, ferroelectric and organic materials will be investigated.

The second grant, $199,400, will finance research in neutron physics. The Institute's nuclear reactor and special auxiliary equipment will aid in this phase.

Synthetic Rubber Will Protect *Minuteman* Motors

The motor cases in *Minuteman's* third stage will be protected by a synthetic rubber liner developed by Goodyear Tire and Rubber's Aviation Products Division.

The liner is fabricated in varying degrees of thickness ranging from 0.1 to 1.2 in. and burns out with the solid-propellant grain. The insulator is about 5.5 ft. long and over 3 ft. in diameter.

Morgan E. McMahon: Formerly manager of product engineering, appointed manager of Pacific Semiconductors, Inc.'s engineering department, succeeding **R. A. Campbell,** recently elected vice president in charge of operations. He will be responsible for overall engineering activities with special emphasis on the firm's transistor program.

McMAHON

Elmo E. Maiden: Named assistant manager of the engineering department with special responsibility for the PSI micro-electronics program and the establishment of the micro-diode plant.

Karel J. Bossart: Assistant to the vice president-engineering for Convair Division of General Dynamics Corp., chosen by the Institute of Aeronautical Sciences to receive the Sylvanus Albert Reed Award for 1959. He was cited by the I.A.S. "for significant contributions to the design and development of the *Atlas* ICBM." He headed the Convair engineering team that developed the free world's first ICBM, starting in 1946.

BOSSART

Dr. Charles K. Leeper: Formerly manager of the development division of Nuclear Development Corp. of America, named director of Atlantic Research Corp.'s Mechanical Engineering Division. Will also be responsible for the operations of the Prewitt Aircraft Co., a recent affiliate.

LEEPER

Other additions to Dr. Leeper's staff: **Dr. A. W. Armstrong,** formerly senior research engineer at Convair, acts as consultant to the design engineers, and handles the precontract and report work, as well as the estimating, scheduling and internal liaison.

Eugene C. Mooring: Formerly assistant chief of the Plastics Section Testing Division of Douglas Aircraft Co., will handle fabrication and application of plastics to missiles and rockets.

Newton F. Spraggins: Former president of Rudolph, Inc., named engineering supervisor in the Mechanical Engineering Div.

John L. Lavoie: Formerly with North American Aviation's Rocketdyne Div., will head the rocket design group of the company's Research Mechanical Engineering Div.

Fred F. Richards, Sr.: Elected section manager of production for Temco Electronics, division of Temco Aircraft Corp. He will be responsible for assembly of guidance apparatus, power supplies, antennas, radar devices and subminiature telemetering equipment.

John C. Keyes: Promoted to manager of the satellite systems engineering department at Philco Western Development Laboratories. He will direct WDL's part in the *Discoverer* satellite, systems engineering, range design and operation, systems design and integration and the advanced applications sections.

KEYES

Thwing-Albert Instrument Co., elects **John Fachet,** vice-president-manufacturing; **Ralph E. Green,** vice-president, technical sales and quality control; and **Charles A. Paul, Jr.,** secretary.

George A. Zink: Appointed director of process developments for the newly-created defense systems division of General Motors at Warren, Mich. He will engage in research and experimentation aimed toward the design and development of weapons systems and related activities.

W. S. "Stan" Johnston: Assumes overall responsibility for all airfoils operations of the Tapco Group of Thompson Ramo Wooldridge, Inc., which includes operations at the Harrisburg and Danville, Pa., plants.

Dr. Jay Tol Thomas: Appointed director of engineering for the Boston Division of Minneapolis-Honeywell Regulator Co.

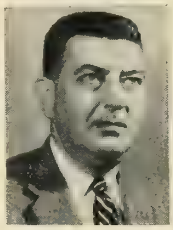
Previous posts: Manager of the Systems Laboratory, Sylvania Electric Products Division where he specialized in infrared and ultraviolet detection of electromagnetic propagation, phased-array radars and weapon system management.

THOMAS

Charles W. Creaser, Jr.: Appointed head of Antenna Systems, Inc., a newly formed company engaging in design and production of precise antenna systems and related accessories. The founding group is composed mostly of former staff members of D. S. Kennedy & Co. Areas of interest will include scatter communication, tracking, radar and radio astronomy.

Allen G. Gatfield: Named assistant engineering director at Rixon Electronics, responsible for technical direction and guidance of all active project engineers. Was formerly project manager, Components and Instrumentation Laboratory, ITT Labs.

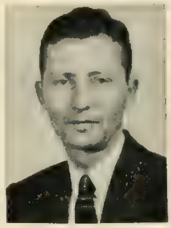
John F. Cain: Named president of Greer Hydraulics, Inc., designers and manufacturers of hydraulic systems, components and missile ground support equipment. The company, currently situated at New York International Airport, will shortly move to new headquarters and plant nearing completion in Los Angeles.



CAIN

Alfred L. Fenaughty: Elected vice president and general manager of Computer Control Co.'s Western Division, responsible for all activities including digital systems, engineering and product development.

Previous posts: Manager, computer developments, Remington Rand UNIVAC Division of Sperry Rand and Engineering Associates where he worked on advanced techniques and systems.



FENAUGHTY

Walter J. Yuss: Named general manager and **W. J. Drummy,** manager of engineering and sales for Adel Precision Products, designers and manufacturers of hydraulic and pneumatic equipment.

Lee W. Topham, chief engineer will direct design and development operations.

Russell A. Hughes: Appointed chief applications engineer for Pacific Scientific Co.

Henry Erfurt: Elected to head the newly established Epsco, Inc.'s Washington, D.C. office.

George Anisman: Named research and product planning manager of Telecomputing Corp.'s Whittaker Controls Division. Was formerly manager of applications engineering for Sundstrand Turbo Co.

Ralph S. White: Elected general man-
ager of Electronic Systems Development Corp., a subsidiary of Solar Aircraft Co. He will be responsible for the manufacturing and business functions of the firm. Was previously assistant to the division manager of Beckman Instruments, Inc.

Fred Horowitz: Joins U.S. Transistor Corp. as development and project engineer. Horowitz, a solid state physicist, was formerly with the Zenith Corp.

Dr. H. Norman Abramson: Named director-applied mechanics for the Southwest Research Institute.

Dr. Joseph Fugger: Appointed senior scientist with the tactical weapons operation of Aeronutronic division of Ford Motor Co.

Previous posts: scientific coordinator in chemistry, McGraw-Hill Co.; research specialist, Boeing Airplane Co.; and a research group leader, Thiokol Chemical Corp.

Dr. C. C. Baum: Former vice president and director, elected president of the TE Company, engaged in research and development of prototype products and systems involving electronic, optical and mechanical units. Succeeds **Dave Evans** who resigned to head the Dave Evans Enterprises.

Paul W. Crapuchettes: Former chief engineer, promoted to technical director of the Litton Industries Electron Tube Division. He is also manager of the Magnetron Product Line.

Charles E. Applegate: Appointed a staff specialist-new products at Sylvania Electronic Systems division of Sylvania Electric Products, Inc., responsible for new product planning, and development programs. Was previously a member of the senior engineering staff of Arthur D. Little, Inc., and earlier associated with the sales and engineering divisions of Leeds & Northrup Co.

The Institute of the Aeronautical Sciences announces the winners of a number of important aeronautical awards for 1959:

The Hill Space Award goes to **Dr. James A. Van Allen** for the discovery of the radiation belts above the earth which now bear his name.

The John Jeffries Award to **Brig. Gen. Don D. Flickinger, M.D.,** USAF, M.C., "for outstanding contribution to the advancement of aeronautics through medical research."

The Lawrence Sperry Award, to **Dr. James E. McCune,** senior scientist of Aeronautical Research Associates of Princeton, designed to honor a young man of outstanding achievement in the aerospace field.

William S. Ivans, Jr. and **Robert E. McDowall:** Elected directors of Cohu Electronics, Inc.

O. K. Kowallis: Promoted to director of research for Wiancko Engineering Co., and will be responsible for all phases of engineering research and development.

Robert L. Nakasone, holder of several patents on electronic instrumentation devices, replaces Kowallis as chief engineer.

Aeronutronic Realigns Research, Management Jobs

Aeronutronic Division of Ford Motor Company has announced a major change in its basic and applied research activities, and a shift in key management positions.

Dr. Montgomery H. Johnson has been elevated to a top-level scientific advisory position and Dr. Lloyd P. Smith, general operations manager, will head Aeronutronic's Research Operations. This department is a consolidation of all basic research functions.

Four key personnel appointments within Research Operations were announced in the reorganization: Dr. Arthur J. Ruhlig, manager of Physics and computing; Cravens L. Wanlass, manager of Solid State Devices; Dr. Leon Green, acting manager of Aerothermochemistry and Materials; and Dr. Lawrence Davanau, manager of Planning.

IAS Meeting Stresses Space Effort

More than half of the sessions at the 28th Annual Meeting of the Institute of the Aeronautical Sciences, in New York, Jan. 25-27, were concerned with the space effort.

As a service to M/R readers, abstracts of some of these papers are presented. Copies may be obtained from the IAS, 2 East 64th St., New York 21, N.Y., for a nominal fee.

Status of Electric Propulsion, Robert H. Boden, Staff Scientist, Rocketdyne Div., North American Aviation, Inc.

Five years ago the thinking about electrical propulsion systems was limited to few individuals in a small number of industrial organizations and governmental agencies The concepts of the electrical systems were often colored by those of the chemical rocket. Within this span of five years many of these ideas have become clarified. As a result, these ideas have germinated into promising electrical rocket systems.

The source of the energetic particles from which the thrust is developed is plasma generated from electrical discharges The one exception to this is the surface contact ion engine in which electrons are stripped from the propellant on a heated metal surface. The engines in which the particles are brought to the enery level required by the mission of the vehicle in which they are applied have three basic subsystems: the energy source, the power converter, and the thrust chamber.

The paper reviews the basic analyses of the electrical rocket engine. Four energy sources: conventional, the fission nuclear reactor, solar and the fusion reactor, power conversion; and three basic thrust devices: electrostatic, electrothermodynamic and magnetohydrodynamic, are reviewed and compared. Major emphasis is upon the thrust device.

Electric Energy Sources and Conversion Techniques for Space Vehicles, Volney C. Wilson, Res. Lab., General Electric Co. IAS Paper No. 60-31.

Electric generators for space vehicles must be dependable, have long life and be lightweight. For long life the primary energy source should be solar energy or atomic energy. Of the various ways to convert heat into electricity the most promising systems for space vehicles utilize thermionic converters. Their operation is described. A consideration of the characteristics of thermionic converters explains why they are promising for space vehicle power supplies.

Solar Sailing, Theodore Cotter, Physics Dept., Univ. of Michigan.

The history of the solar sailing idea is briefly recounted. The propulsion characteristics of an ideal solar sailing space vehicle under the influence of solar thermal radiation are described. Three classes of maneuvers are discussed quantitatively: satelloid maneuvers, escape into interplanetary space, and interplanetary trips. Two engineering realizations of a solar sailing which are proposed: a centrifugally stressed spinning disc, and a cantilevered disc. Techniques for launching and orienting each of these are suggested. Effects due to the space environment, as they bear on the practical usefulness of the solar sail, are estimated It is concluded that solar sailing is an extremely promising concept for space propulsion, and that there are no major technical obstacles to an early trial of such a device.

Pebble Bed Nuclear Reactor for Space Vehicle Propulsion, Myron M. Levoy and John J. Newgard, Reaction Motors Div., Thiokol Chemical Corp. IAS Paper No. 60-39.

Pebble bed nuclear reactors are applicable for nuclear space rocket propulsion, within limits. They may be used for low-flow, low-thrust space vehicles with gross weights in the range of 20,000 lb. to 100,000 lb. and initial accelerations from earth orbits of 0.2 to 0.4 g.

The reactor and nuclear vehicle schemes are discussed and advantages are considered. Savings in fabrication and construction costs and reactor design simplicity are indicated. Problem areas are also discussed, such as the power flattening requirements, hydrogen density perturbation effects on system reactivity, and peripheral flow build-up.

Thermal Stresses in Missile Nose Cones, A. J. A. Morgan, Pres., Aeronautical Engrg. Res., Inc., and Carlos H. Christensen, Mathematician, Digital Sect., Computation Lab., Army Ballistic Missile Agency. Fairchild Fund Paper No. FF-24.

A general computational scheme is developed for the determination of the thermal, and other displacements and stresses within multi-material bodies with axial symmetry. The formulation is of the quasi-steady type; it is made in terms of general curvilinear coordinates; hence, within the class considered, it is not restricted to a particular body shape or to "shell-like" structures. The generality of the method is increased by supposing that it may be necessary to use a discontinuous metric tensor to describe the geometry in two adjoining regions of the body.

Some Aspects of Designing Aluminum Structures for Thermal Environments, John M. Cord, Project Engr., Adv. Design, Bell Aircraft Corp., and A. Bruce Burns, Senior Res. Engr., Missiles and Space Div., Lockheed Aircraft Corp. IAS Paper No. 60-7.

Design aspects of aluminum structures subjected to thermal environments consisting of elevated temperatures are reviewed, and the nature of the design of thermal environment for typical aircraft is noted. The problems associated with extending the structural use of aluminum for aircraft in the Mach 2.0 to Mach 3.0 region are discussed in the light of current experience.

A simplified method for determining the room temperature strength of aluminum alloys after exposure to more than one elevated temperature is introduced, and the results of a test program to substantiate the method are presented. This method is based on a cumulative strength deterioration relationship which takes a form generally similar to the familar cumulative damage or life fraction method for fatigue strength. Applications of the cumulative deterioration relationship and its relationship to the overall elevated temperature structural design problem is discussed

Heat Protection by Ablation, Robert M. Wood, Ch., and Ronald J. Tagliani, External Thermodynamics Gp. Leader, Thermodynamics Sect., Missiles and Space Systems Engrg. Dept., Douglas Aircraft Co., Inc. IAS Paper No. 60-8.

A model consisting of a metal load-carrying structure covered with a protective coating is discussed and chosen as an efficient method of dissipating the severe heating encountered by hypersonic vehicles in transient flight. The concepts of heat and temperature of ablation are used together with other coating material properties for describing the effectiveness of different protective coatings in different thermal environments.

The assumption of an equivalent square wave heat-time input for any actual environment is discussed and justified for radically different environmental situations, including ICBM, Mars entry, anti-ICBM, manned entry, and nozzle applications. Using the square wave heat input assumption the unit coating weight required is presented as a function of intensity and duration of heating for several different protective coatings.

Three domains of heating are categorized: (1) almost complete ablation, wherein the most important material property is heat absorbed per pound of material lost; (2) partial ablation, wherein density and conductivity are as important as ablation properties; and (3) no ablation, wherein ordinary thermal properties are all important.

The results are summarized by the graphical presentation of the relative coating weights required with a number of popular protection materials for a number of different environmental situations, thereby emphasizing the need for different thermal properties with various environments.

The Application of Solid Propellant Rocket Motors to Boost Space Vehicles, Giulio C. Panelli, Res. Specialist, Missiles and Space Div., Lockheed Aircraft Corp.

This paper describes work performed by the author and associates at Lockheed under a contract with the NASA. The work includes a comprehensive performance analysis of large, solid-propellant rocket motors as first-stage boosters for vehicles designed to perform space missions. Studies have been performed from a vehicle standpoint and include variations of significant design and performance parameters. Detailed investigations have been conducted in structural designs, trajectory techniques and in propulsion design. Brief studies were made with respect to cost and logistics.

The results of the study show that the solid-propellant rocket booster is feasible from performance and design standpoints. A liquid-propelled, three-stage vehicle weighing one million pounds can place 34,400 pounds of payload in a 300-nm orbit. A solid-propellant-boosted three-stage vehicle of the same size can place 42,000 pounds of payload in the same 300-nm orbit. A solid-propellant rocket motor to be used as a booster for this vehicle can be built at the present time with no further advances in technology.

Considerations in the Design of Chemical Rocket Powerplants for Space Applications, Stanley Lehrer, Sect. Supvr. Technical Planning Dept., Reaction Motors Div., Thiokol Chemical Corp. IAS Paper No. 60-24.

This paper discusses a number of the im-

portant factors to be considered in the design of space engines including:

1. Selection of engine type and basic design parameters.
2. Selection of propellants.
3. Multiple start-shutdown capability.
4. Throttling schemes—as related to performance and cooling.
5. Environmental factors.

Other pertinent considerations discussed include:

1. Use of advanced high-temperature materials and lightweight corrugated or other composite constructions.
2. Suitability for manned application.
3. Optimum propellant tank pressurization techniques.
4. Powerplant installation considerations.

Cryogenic Propellant Storage for Round Trips to Mars and Venus, George R. Smolak, Res. Engr., Propulsion Systems Div., and Richard H. Knoll, 1st Lt. USAF, Lewis Research Center, NASA. IAS Paper No. 60-23.

For the more ambitious space missions being considered, such as manned expeditions to Mars, the use of storable chemical propellants of moderate specific impulse results in prohibitively large and heavy space vehicles. Sizable gross weight reductions would result if the higher-specific-impulse cryogenic propellants (hydrogen, fluorine, and oxygen) could be employed. The effective use of these cryogenic propellants for long-duration space missions depends strongly on whether practical means can be devised to keep evaporation losses to a tolerably low level.

The paper discusses the sources of heat to which the cryogenic propellants are subjected and various means that can be employed to minimize evaporation losses. For a round trip to Mars, it is shown that radiation shielding, insulation, and vehicle orientation can be used effectively to keep the cryogenic losses to an acceptable amount. The thermal protection devices employed and the propellant losses for each phase of the Mars trip are discussed.

Propulsion Requirements of a Manned Lunar Mission, Douglas E. Serrill, Proj. Mgr., Space Res. Systems, and H. J. McClellan, Staff Engr., Flight Technology, Aerospace Div., Boeing Airplane Co. IAS Paper No. 60-30.

Man's main motivation for a visit to the moon is one of exploration. The worth of this exploration cannot be defined in detail with any assurance of payoff; however, this exploration is inevitable just as was the climbing of Mount Everest. It can be very clearly stated, however, that man's eventual landing on the moon is completely dependent on good, sound, hard-hat propulsion developments.

There are several ways to accomplish manned lunar missions, including single straight-shot launch systems capable of carrying the payload to the moon and systems utilizing earth orbital assembly of the payloads required for the continued trip to the moon and return. This paper does not compare the various concepts for accomplishing the mission, but rather discusses a few of the major propulsion requirements required to support any one of the ways of doing the job.

Ultrasonic Welding and Improved Structural Efficiency, J. Byron Jones, and Harold L. McKaig, Aeroprojects, Inc. IAS Paper No. 60-10.

Ultrasonic welding is an effective means for producing leak-tight junctions of structural integrity in the high-strength, high-temperature, refractory metals and alloys, particularly in thin gages of these materials. Data are presented for ultrasonic weld strength in a number of structural materials, weld seam leak-tightness, fatigue, and for strength degradation produced by ultrasonic welding in certain high-strength stainless steels and titanium alloys.

The ultrasonic welding process is described briefly, representative microstructures are illustrated, and the functional components of various types of equipment —spot-type, ring, and continuous-seam welders—are schematically illustrated.

Role of the Satellite in Space, Fred L. Wipple, Dir., Smithsonian Astrophysical Observatory and Prof. of Astronomy, Harvard Univ.

Artificial earth satellites and space probes offer an entirely new tool for astronomical research, a tool with almost unlimited potentialities. Research areas of immediate interest are:

a) The interplanetary medium including meteorites, gas, ions, and plasma.

b) Solar activity. Of particular interest are emissions of the far ultraviolet, X-rays, infrared, long-wave radio, cosmic rays and possibly gamma rays.

c) Lunar and planetary investigations both by observation from near the earth and by actual exploration.

d) Interstellar space and nearby stars to be studied by the same gamut of radiations as mentioned for the sun.

e) The Milky Way and other galaxies. Results in this area will depend upon the transparency of space at great distances, which is not known at the moment.

f) Basic physical experiments involving time, relativity, and gravity, involving instrumentation with clocks, inertial systems and other fundamental measuring equipment.

From these studies will come basic information for engineering in the space sciences, about the origin of life on this and on other planets and for an understanding of the evolution of the planets, the origin of stars and the development of galaxies. Indeed, great progress should be be made towards an understanding of the nature and evolution of the cosmos as a whole. Artificial satellites will be as important a step forward in astronomy as was the invention of the telescope.

On Meteorological Observations from Satellites, Sigmund Fritz, Ch., Meteorological Satellite Sec., U.S. Weather Bureau.

One of the main values of satellites for meteorology is their world-wide view of the earth from high elevations. World-wide observations of clouds, and of the radiative heat budget of the earth, will soon be available. Among other meteorological measurements being considered for the next few years are the temperatures of the stratoshere (spectroscope) and the distribution of precipitation (radar). Most of these observational programs will be managed by the NASA.

Satellite Systems for Commercial Communications, J. R. Pierce, Dir. of Res., Bell Telephone Labs. IAS Paper No. 60-40.

To be used for commercial communications, a satellite communication system should be competitive in cost and quality with any alternative system and should supplement present facilities. This would seem to limit its application to broadband transoceanic links. High reliability and a long assured life seem necessary.

Passive systems require large powers and antennas. The life of passive satellites is as yet unevaluated. No experimental data are available on the life of radio equipment or orientation and station-keeping equipment for active satellites. However, prospects for long-life, low-power, very broadband microwave equipment and power supplies seem good. The delay in a 24-hour "stationary" satellite system may give some trouble because of delay in one hop and more serious trouble in two hops.

Clearly, much research is necessary before the commercial possibilities of various proposed systems can be evaluated. Bell Laboratories is doing experimental work on both passive and active satellite communication.

The Effects of Vehicle Deceleration on the Ablation Characteristics of a Glassy Material, Jerome B. Fanucci, Res. Engr., Missile and Space Vehicle Dept., General Electric Co.

An analysis of the ablation characteristics of a material which melts and then vaporizes is presented. The ablation characteristics of the liquid film at the stagnation point are analyzed by an integral technique. This method has been compared, for the case not including body forces with other theories, and shows excellent agreement. Some results for zero-pressure gradient bodies are also presented.

Boundary-Layer Displacement and Leading-Edge Bluntness Effects in High Temperature Hypersonic Flow, H. K. Cheng, J. G. Hall, Principal Aerodynamicists, T. C. Golian, Assoc. Mech. Engr., and A. Hertzberg, Hd., Aerodynamic Res. Dept., Cornell Aeronautical Lab., Inc. IAS Paper No. 60-38.

Two important features of hypersonic flow over slender or thin bodies are the displacement effect of the boundary layer and the large down-stream influence of leading-edge bluntness. The present paper contributes new theoretical and experimental results which give increased understanding of these effects.

—when and where—

FEBRUARY

Institute of Radio Engineers, American Institute of Electrical Engineers, Seventh Annual Solid-State Circuits Conference, University of Pennsylvania, Philadelphia, Feb. 10-12.

American Society of Mechanical Engineers, American Institute of Electrical Engineers, February Joint Meeting: "Solar Power for Space Vehicles," Department of the Interior Auditorium, Washington, D.C., Feb. 11.

Annual Meeting of American Institute of Mining, Metallurgical and Petroleum Engineers, Sheraton Atlantic Hotel and Statler Hilton Hotel, New York City, Feb. 14-19. (**Metallurgical Society Forum on Navy Materials Problems,** Feb. 15).

National Society of Professional Engineers Winter Meeting, Broadview Hotel, Wichita, Kan., Feb. 18-20.

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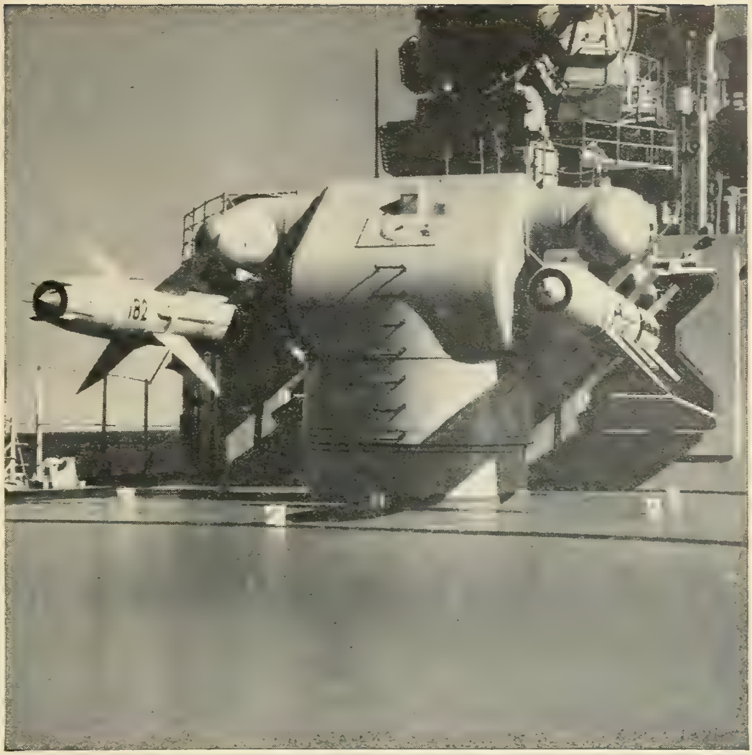


Talos Missiles on dual launcher aboard the U.S.S. Galveston.

Prodding the 'Reluctant Dragon'

It has become almost customary for retiring military officers to leave the ranks of the Armed Services with parting critical barrages aimed at the civilian leadership our national system imposes upon them.

This is not unnatural. We have entered two world wars woefully unprepared, and after each we have disarmed with enthusiastic thoughtlessness. Korea caught us disgracefully weak—and there is considerable doubt whether we really could cope with a similar situation, should it occur today.

Very little of the blame for decisions which led to these situations or events can be laid at the door of the military—unless you wish to blame them for not being persuasive or forceful enough in their protests.

Maj. Gen. John B. Medaris, who has just retired as chief of the Army's Missile Command, made no exception to the custom of parting blasts—and his were pretty well circulated in the public press and on the air.

But Medaris was exceptional in one way, at least by comparison with two recent Army predecessors—Generals Gavin and Taylor. Medaris did not lay the blame on interservice favoritism, did not proclaim his own command or service as the unsung and unrecognized savior.

He placed the blame for the nation's space floundering on the national leadership, and he proposed a remedy—a unified military command. NASA, he thought, could go—because the only excuse for NASA was to take projects from the competitive area and a joint command would do the same thing.

His chief charge—that the Administration's "reluctant dragon" attitude toward space is leading to disaster—is one that has been in the spoken and unspoken thoughts of a great many Americans for months; the almost willful refusal of the White House to recognize the fact that we are in a monumental fight for national survival.

The General's contention that the Services have a great deal of business exploring space, and his call for a unified Space Command, deserve serious thought and consideration.

Most of the great explorations of history were made either by the military, in cooperation with the military, or because there was a military purpose (hidden or otherwise) behind them.

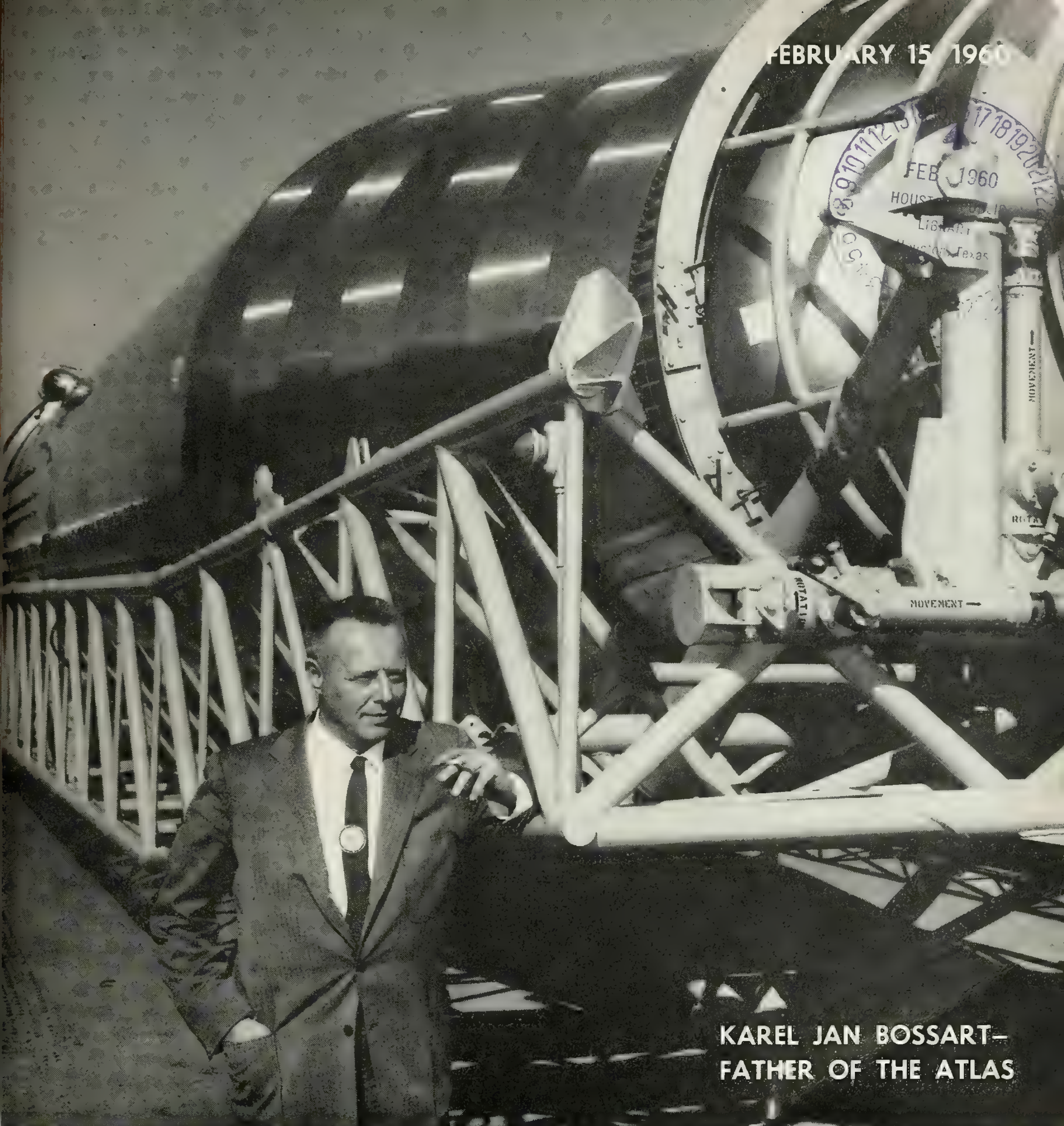
There are reasons why this has always been true—and reasons why it should always be true. One is the sense of driving urgency which compels the military man to be first and strongest because that is the sworn dedication of his life. To him, second place is failure, a dangerous failure. Another reason is the military man's willingness to risk his life and to endure great hardships simply because it is his duty. That's why he is there; if he doesn't feel that way he shouldn't be in the military—and this is a thing people, in peacetime, tend to forget.

This is not to gainsay the dedication or the courage of the men who do not happen to wear the uniforms of the services. Nor to downgrade the skills they have and the contributions they make. Nor there is no place for NASA. There is.

But it is to say that when the United States awakens to the fact that letting Russia win first place and possible control in the space race by default could cost us our freedom, when we arrive at that point and want the strongest possible program to catch up—then we could most nearly guarantee success by giving responsibility for it to a military command, preferably a united command. It is largely a matter of drive and motivation.

Clarke Newlon

FEBRUARY 15 1960



KAREL JAN BOSSART—
FATHER OF THE ATLAS

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

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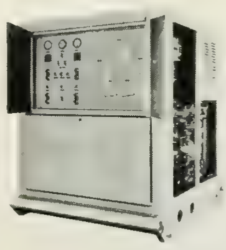

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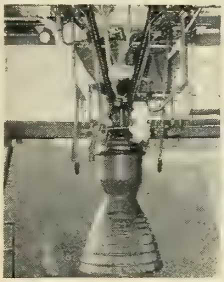
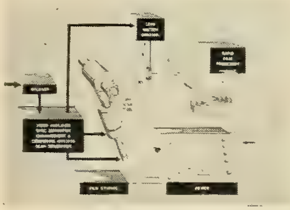
AUDITED PAID CIRCULATION ABC · NBP · READERSHIP Eastman RESEARCH · BUSINESS PAPER LEADERSHIP ABP

COVER: Karel J. Bossart stands before Convair *Atlas*, of which he is popularly called the "father." Bossart has been chosen to receive M/R's Goddard Memorial Trophy. See story on p. 13.



AEROJET, which developed and tested this 100-K static test hydrogen engine, is one of contenders for NASA contract for top-stage of *Saturn*. See report on page 10.



GROUND receiving equipment of Photoscan system developed by CBS Laboratories and called ideal for surveillance work. A report begins on p. 18.

MATERIALS engineer Harry B. Porter of NOTS proposes "Calorobics" as a term to cover the field of high-temperature materials technology. See p. 24.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

31,000 copies this issue

FEBRUARY 15 HEADLINES

ASTRIONICS

ADVANCED MATERIALS

INTERNATIONAL

PROPULSION

PRODUCTS AND PROCESSES

THE MISSILE WEEK
U.S. Reg. Pdg.

DEPARTMENTS

Washington Countdown

IN THE PENTAGON

Funding for *Midas* and *Samos* . . .
in the Air Force's FY 1961 R&D budget breaks out this way:

. . . About $100 million for the *Midas* early warning satellite.

. . . More than $160 million for the *Samos* reconnaissance satellite.

Some top Air Force leaders are pressing for more money for *Midas* in order to achieve an operational system earlier.

• • •

Project *Yo-Yo* . . .
is a Navy study aimed at possible development of a picture-taking reconnaissance satelloid. A *Yo-Yo* would make a single orbit and be recovered at sea.

• • •

Operational *Hound Dogs* . . .
have already been flown more than 500 miles. The first of the North American air-to-surface air breathers is already in the hands of SAC.

• • •

Mobile *Jupiters* . . .
are being sought by the Army. The Army also wants to put the Chrysler IRBM's in Alaska.

• • •

The SAC-*Polaris* Joint Command . . .
proposed by the Air Force is expected to come before the Joint Chiefs of Staff for a decision within the next few weeks. The Navy is ready to fight the proposal to its last boatswain.

• • •

***Jupiter* plus *Agena* . . .**
is reported to be the full drone the Army is planning to pit against its *Nike-Zeus* AICBM during forthcoming Pacific tests. The Lockheed-Bell *Agena* will climb to the desired altitude, stop its engine, coast into a dive and restart for a powered dive to simulate an incoming ICBM.

• • •

The Advanced *Lacrosse* . . .
R&D program is not dead but merely resting. The Army plans to go ahead with the postponed $200-million Martin program as soon as it can get the money.

Vulnerability to jamming . . .
to some degree is one of the key problems the *Advanced Lacrosse* is expected to lick. Meantime, four of eight planned *Lacrosse* battalions are scheduled to be sent to Europe and Korea as soon as their training is completed.

• • •

The Canaveral shot program . . .
boasts an average of a launching a day this week. The schedule includes a *Thor, Matador, Titan, Polaris, Snark* and an *Atlas.*

ON CAPITOL HILL

More money for defense . . .
primarily for *Polaris* submarines and an airborne alert, appears to be in the cards as the Missile Gap debate roars on. However, the Administration appears equally determined not to spend the extra funding even if Congress provides it.

• • •

Minor revisions . . .
in military procurement procedures may be enacted by Congress before it adjourns this year. However, no major changes are now expected to result from current hearings and studies in the Senate.

AT NASA

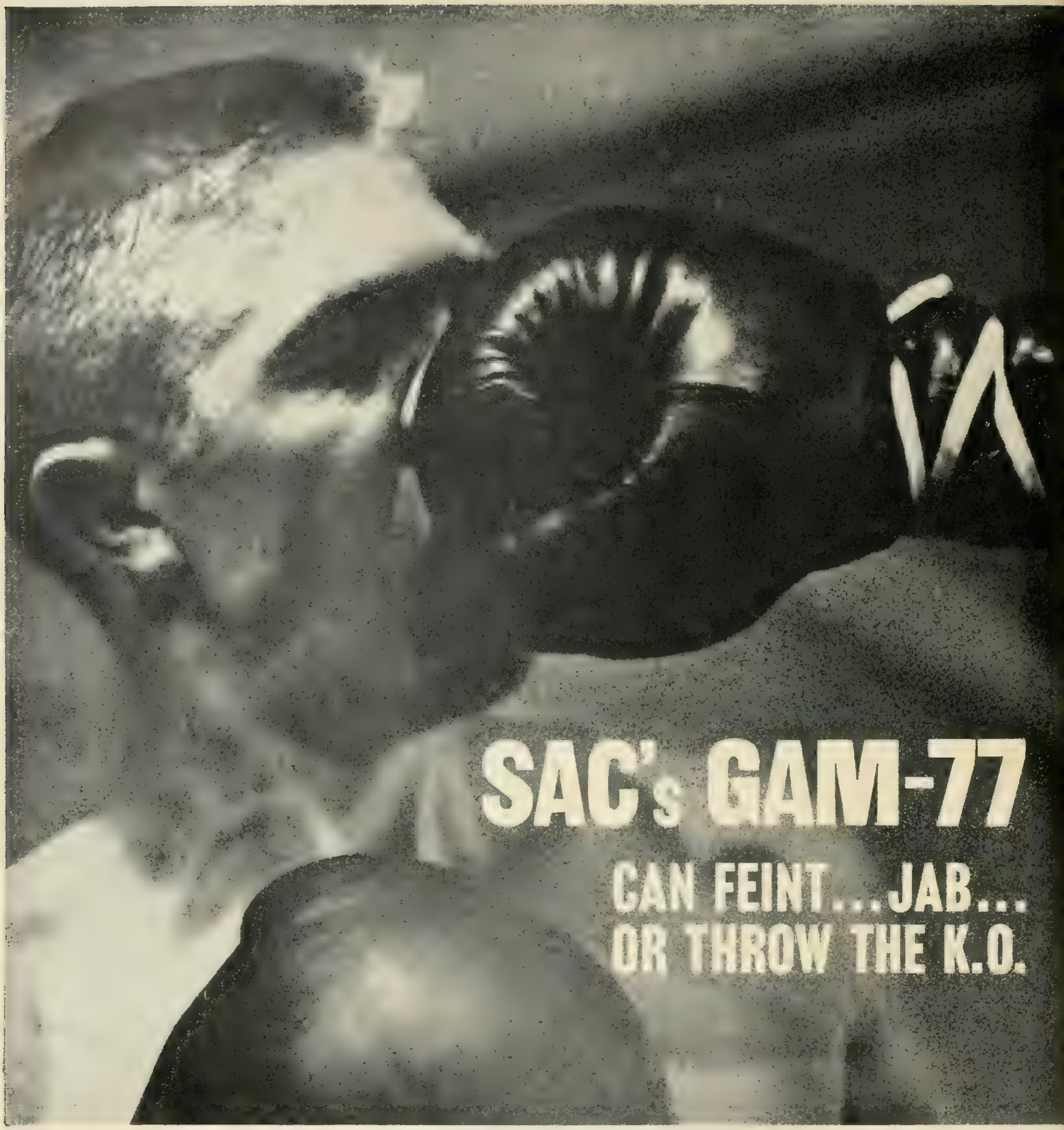
A doubled program . . .
for launching sounding rockets is under way at Wallops Island Test Center. NASA plans to launch 100 sounding rockets from Wallops during 1960—compared to about 50 last year. About eight a month will be fired during the next two years.

• • •

A wary eye . . .
is being cast by NASA officials at the Air Force proposal to develop a two-million-pound-thrust solid-rocket motor. NASA contends the White House gave it the authority to develop the nation's big boosters and the reason it isn't considering work on a large solid motor is that it lacks the money.

• • •

Another supplemental request . . .
NASA's second for FY 1961—may be in the works. So far, NASA budget requests for FY 1961 total $915 million. The agency also has submitted a $25-million supplemental request for FY 1960.



GAM-77 HOUND DOG air-to-surface missiles give SAC's B-52G intercontinental bombers the versatility of a champion boxer. Even while the aircraft carrying the GAM-77 missiles is airborne, a new target can be selected. Then reaching out at supersonic speeds after launch, the GAM-77's can flatten opposition for the bomber to deliver its own Sunday punch...or independently destroy the primary target. These jet-powered missiles vastly increase the striking power of the giant Boeing B-52...give it a triple-punch capability.

Guided by a self-contained inertial autonavigator—set before launch by the B-52's crew—the GAM-77 can't be jammed, can't be decoyed. The GAM-77 Hound Dog was designed and is being produced for the USAF by the Missile Division of North American Aviation.

MISSILE DIVISION

NORTH AMERICAN AVIATION, INC.

Downey, California

Industry Countdown

MANUFACTURING

Shear-off of nose cone . . .
is believed to have caused a *Titan* ICBM to disintegrate 57 seconds after launch Feb. 5. The failure came on the second attempt to test second-stage ignition. The nose cone was being tried out as a secondary test objective.

• • •

***Titan*'s troubles . . .**
which probably will be examined soon by Congress, may make it extremely difficult to meet the operational target date—set for May, 1961.

• • •

Leading contenders . . .
for the contract to build the frame for the "interim" 80K-thrust *Saturn* second stage are Convair and Douglas. The soon-to-be-awarded two-year job may be worth between $100 million and $200 million and could lead to contract for an "ultimate" 800K stage—and another $200 million.

• • •

Reorganization of weapons . . .
system management set-up by the Air Force is still considered a must. The chief obstacle: reconciling different philosophies of ARDC Commander Schriever and Gen. Anderson, chief of the Air Materiel Command.

PROPULSION

Considerable upgrading . . .
in the 300,000-lb.-thrust of the *Titan* booster is predicted if—and when—the big bird is switched to storable non-cryogenic fuels. A storable *Titan* would be heavier than the LOX and RP-1 fueled model, but would be able to deliver a larger megaton payload a greater distance (see p. 30 this issue).

• • •

Two sections . . .
fabricated individually are proposed for the Aerojet-General 2-million-lb.-thrust solid booster. Outside dimensions of the assembled rocket: 60-70 ft. high and up to 13 ft. in diameter. Aerojet already has fired small solid rockets constructed in sections.

ASTRIONICS

Russia has just opened . . .
a new planetarium at Astrakhan, which is located at the mouth of the Volga where it enters the Caspian Sea. The planetarium is also located between Kapustin Iar and Aralsk —the two major Red ICBM-satellite launching sites (See map page 26).

• • •

Defense systems department . . .
of General Electric—believed the first in industry set up solely for systems engineering of Army missile programs—is now reported to be working on several classified contracts and to have some more in the works. The special department was created at GE Philadelphia about six months ago.

• • •

Operational *Bullpups* . . .
are now showing 90-95% reliability. This is particularly signficant since the air-to-surface missile is unpacked, loaded and fired with no checkout. Navy claims $7 million savings in a year with this technique and is promoting its further application to other missile systems.

WE HEAR THAT—

Contract to engineer . . .
silo elevator-erector for a hardened *Atlas* ICBM is going to American Machine & Foundry, which developed similar mechanism for *Titan*. The contract is expected to be about $4 million . . . An Atomic Energy Commission official—Delmar M. Morris—is the new deputy director for administration of the ABMA-NASA facility at Huntsville . . . The Leach Corp. has acquired Electro-space Laboratories Inc., Pasadena, a developer of subminiature solid-state missile command receivers . . . Sales are improving at Fairchild Engine & Airplane Corp.'s Plastic Branch, which is doubling its plant capacity at Copiague, L. I. . . . Missile Gap Thought of the Week: "The danger is not in starting too many R&D projects," says J. R. (Russ) Clark, general manager of Chance Vought's Astronautics Division. "The real danger is in not starting enough. R&D spending is the seed corn. What is needed is the courage, vision and determination by a good farmer to weed out the less promising plants after they have sprouted and before they grow too far above the ground—regardless of the pressures to let the weeds grow and sap strength from the good plants." Russia reportedly is spending $8.1 billion this year on missile/space R&D.

H-O Engine Contract Race On

Bids due March 14 for NASA's 200,000-lb. thrust hydrogen-oxygen engine which will go on top of Saturn

by Paul Means

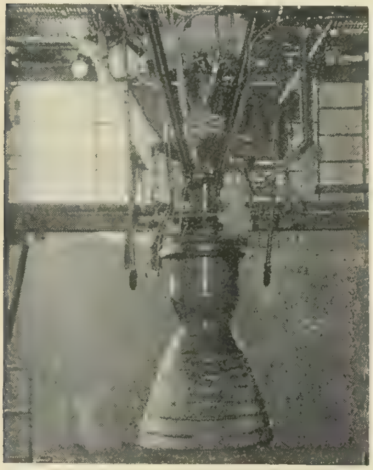
The race is on among major missile industry rocket engine manufacturers for supremacy in the liquid hydrogen engine field.

At stake is a NASA contract for a 200,000-lb.-thrust liquid hydrogen-oxygen engine which will eventually go on top of the *Saturn* cluster.

Companies entered in the competition—at NASA's invitation—are Bell, Aerojet-General, Thiokol, Pratt & Whitney, AiResearch of Garrett, Rocketdyne and General Electric. These companies were briefed last week at a NASA pre-bidders' conference. The formal request for bids will go out Feb. 15 and bids will be due March 14. NASA expects to let the contract by late April.

The project has been funded for $16 million so far; $8 million in the FY '61 budget under the liquid propulsion R&D item, and $8 million in the supplemental FY '61 budget under the Project *Saturn* item. The developmental funding, leading up to preflight rating tests in 1963, is expected to cost about $50 million.

The preliminary specifications given to the seven companies by NASA last week were sketchy in places, because no one has ever built a large thrust operational hydrogen engine before.



AEROJET'S LOOK Hydrogen-oxygen engine undergoes test at California facility.

Bid Specifications

The prime requirement in the 200-K hydrogen engine is high reliability, the National Aeronautics and Space Administration told bidders at a conference Feb. 3.

Some sacrifice of performance and weight will be in order, NASA officials said, since the switch to hydrogen gives an increase in specific impulse from 300 to more than 400 seconds.

NASA said it gave the seven bidders these other instructions on drawing plans for the engine:

- *Don't go beyond the present state of the art; no new concepts in engine hardware are desired.*
- *Start and restart capability are required—without significant modifications in design.*
- *Expenditures for new facilities—particularly test areas—must be held to a minimum. If possible, modify existing facilities for the development job.*
- *Simulated altitude testing, when the time comes, will be performed at a government installation.*

As to the use of a gas generator or a regeneratively cooled nozzle, NASA officials were noncommittal. The length of the engine was also left open.

NASA set a diameter limit for contractors but declined to disclose the figure. However, since four engines must fit within the 220-in. diameter of the second stage, it is obvious that the engine must have about an 85-in. diameter.

The companies were told that four of the engines would have to fit in a 220-in. diameter frame—leaving room for about an 85-in. diameter engine—and were given the expected performance characteristics.

The NASA Specifications demanded high reliability of the proposed engine and use of a gas generator or regenerative cooling nozzles was made optional. No requirement was placed either on the length of the tankages.

• **NASA coppers its bet**—NASA and its new Huntsville team had taken a bold step when they decided to go beyond the present state of rocket engine art for *Saturn's* upper stages. If the job proves more difficult than expected, the decision might slow down the *Saturn* program considerably. But if the proposed engine's development proceeds on schedule, *Saturn* will be more powerful, and have greater capability than its original backers had dreamed possible.

But the NASA-*Saturn* team has not put all of its eggs in the large-hydrogen-thrust-engine basket. A bidders' conference was held at Huntsville last week for a contract to cluster the 20,000-lb. Pratt & Whitney version of the *Centaur* hydrogen engine to use as *Saturn's* interim stage. (See M/R, Feb. 8, p. 14.) These engines are expected to be ready for the *Atlas-Centaur* in mid-1961, and ready for *Saturn* in their four- and two-barrel configuration in 1962.

Contract to fabricate the 200-K engine into its four- and two-barrel configurations will not be let by NASA for some time yet, but it is thought that the winner of the NASA contract to fabricate the 20-K stages will take a long march on its competitors and

PRATT & WHITNEY'S 15,000-lb. thrust hydrogen engine is *Centaur's* second stage.

will be in a good position when the contract to fabricate the 200-K stages is bid on. Convair and Douglas are considered to be the strongest contenders in the 20-K engine stage fabrication race.

• **A look at the field**—Of the seven companies vying for the 200-K hydrogen engine contract, Pratt & Whitney, Aerojet-General and Rocketdyne are considered to be in the strongest positions, but the other four competitors all have considerable knowledge and facilities.

Pratt & Whitney's strong position results from its work on what will be the first operational hydrogen engine of any size. Aerojet-General has developed under an Air Force study contract a 100-K static test hydrogen engine which has been tested about 60 times. Rocketdyne has had success in building large hydrogen pumps for Project *Rover*, and is the largest producer of cryogenic engines.

Of the other competitors, Bell Aircraft has considerable experience in the cryogenic field, especially in developmental engine work with fluorine, and General Electric has done considerable work on starting cryogenic engines at altitude, stopping them, and then restarting them.

Thiokol, principally known for its work in the solid propellant field, nevertheless has considerable experience with liquid rockets—as does AirResearch of Garrett.

• **Availability may be key**—One consideration that might have bearing on who gets the contract is the availability of liquid hydrogen. The proposed engine will be tested at the facility developed by the eventual contractor, and large quantities of liquid hydrogen will be needed.

Air Product's plant at West Palm Beach Fla., the only large production facility in operation, services Pratt & Whitney's *Centaur* plant and might be able to supply Pratt & Whitney's added needs if it wins the 200-K contract. Linde is building a major West Coast facility, due to be completed in April at Torrance, Calif., capable of producing six tons a day. This could service prospective nearby facilities of any winning contractor, and especially the present California facilities of Rocketdyne, Aerojet-General, and AiResearch.

Zeus Dealt Another Budget Blow

The Army's *Nike-Zeus* anti-missile missile program has received another blow—a temporary freeze on its spending program in FY 1961.

The freeze follows the administration's refusal to permit the Army to begin a multi-billion dollar production program for the Western Electric AICBM in the new fiscal year or to release $137 million voted by Congress last year for pre-production operations.

The Administration refusal has set the *Zeus* schedule back from one to two years. The original target date for producing an operational *Zeus* battery was 1963.

The new freeze on *Zeus* limits R&D spending in FY 1961 to $200 million—$87 million less than the budget includes for the program in new money. The Army also is being permitted to go ahead with using the $15 million more included in the budget for construction of *Zeus* testing facilities at Kwajalein and Johnson Islands in the Pacific.

Army Secretary Wilber M. Brucker told the House Military Appropriations Subcommittee that the freeze is causing "a great deal of dismay" because the amounts available will not be enough to go forward with the R&D program at full speed, as promised by the Administration.

He said angrily that he has carried the matter to the Secretary of Defense in order to "bring this to a head."

Informed sources said the freeze is only temporary while the Administration re-examines the *Zeus* R&D program again to determine how much will be needed—particularly in regard to missile drones that will be used in the Pacific tests. Some experts have estimated that the drones—modified Chrysler *Jupiters*—will not cost as much as the Army has thought they would.

Nike-Zeus Funding

(Millions of dollars)

	Appropriated	Direct Obligations	Expenditures
Fiscal Year 1958 and prior:			
Procurement of Equipment and Missiles (PEMA)	$ 34.1	$ 34.1	$ 10.6
Research, Development, Test and Evalution (RDT&E)	32.0	32.0	21.1
Military Construction (MCA)	1.1	1.1	.2
Total	67.2	67.2	31.9
Fiscal Year 1959:			
PEMA	172.3 (1)	163.6	67.6
RDT&E	39.5 (2)	35.0	21.6
MCA	30.9	12.0	3.2
Total	242.7	210.6	92.4
Fiscal Year 1960:			
PEMA	137.0	0	86.0
RDT&E	239.0	237.8	204.0
MCA	61.0	60.0	21.1
Total	437.0	297.8	311.1
Fiscal Year 1961:			
PEMA	0	0	24.0
RDT&E	287.0	287.0	253.0
MCA	15.0	15.0	47.2
Total	$ 302.0	$ 302.0	$ 324.2
GRAND TOTAL	$1048.9	$ 877.6	$ 759.6

(1) Includes $42,000,000 transferred from ARPA.
(2) Includes $15,500,000 transferred from ARPA.

The sources contend that there has been no change in the *Zeus* R&D schedule. However, wary Army officials add to this two words—"so far."

Brucker, in testimony before the House subcommittee, disclosed that the Army originally sought $1.537 billion in new money for FY 1961—$1.235 billion more than the Administration agreed to put in the budget.

The original request included $805 million for production and $389 million for construction of bases. The Army also originally sought $328 million for R&D—$41 million more than was granted.

Navy Preparing to Ask For 6 More FBM Subs

The Navy has told the Administration that if it gets a go-ahead now it can begin launching a *Polaris* submarine a month by 1962.

Average cost for each including all support equipment: About $150 million.

The Navy disclosed it already is preparing to ask the Administration to approve adding six more *Polaris* submarines to the FY 1961 budget, bringing the total in the budget to nine. That would bring the total in the 1961 budget to nine and the total number authorized to 18.

Total cost for the extra six including tenders and other support equipment: $975 million.

Adm. Arleigh Burke, Chief of Naval Operations, told the combined House Space and Preparedness Committees that he was hopeful that the Administration would agree.

"We have passed all the big milestones that we have set for ourselves," Burke said. "The last few tests of *Polaris* have been so successful that we believe it will soon be completely operational."

However, as the week ended, Gen. Nathan Twining, Chairman of the Joint Chiefs of Staff, made clear that he opposed increasing the *Polaris* sub construction program at this time.

Lanphier Hits Ike's Missile Policies During Plant Tour

SAN DIEGO—Maj. Gen. O. J. Ritland, commander of the Air Force's Ballistic Missile Division, confirmed that Convair's *Atlas* missile can carry a payload meeting military requirements to a range equal to or better than the 7600 miles demonstrated by the Russian firing into the Pacific.

Gen. Ritland said there is not a single area of the *Atlas* program in which the requirements have not been exceeded. His remarks were made as the *Atlas* production line was opened to the press for the first time.

Convair Vice President Thomas G. Lanphier, Jr. told newsmen who toured the production line that the *Atlas* "can fly as far, hit as accurately and carry as much weight as the *Titan*."

• **Ike strongly attacked**—Lanphier made a blunt attack on the Administration for missile policies which he said leave this country far behind the Soviet Union in offensive missile capabilities.

"The President of the U.S. is taking dangerous, very dangerous chances on our survival in the next few years," he said. "I don't think he has that right."

Lanphier said there is little that can be done now in narrowing the gap except to keep Strategic Air Command bombers on airborne alert over the next 24 months.

Lanphier explained that he was speaking as an individual, not as a Convair vice president. The bluntness of the remarks by the outspoken Convair vice president shocked some Eastern newsmen.

In the final assembly area and on trailers outside the plant, newsmen saw some 25 *Atlas* missiles. They were asked by the Air Force not to reveal the exact number of final assembly racks, which number about 15.

• **Plea for more space work**—Lanphier said the *Atlas* production line is operating at only 50% capacity. He said that with the addition of only a few more employees, Convair could double *Atlas* production almost immediately. But he pointed out that for military purposes, it was not just a question of turning out missiles but also of establishing bases and training crews, which required a lead time of not less than two years.

Convair executives urged, however, that greater use be made of the *Atlas* in space programs. "Only a handful of *Atlases* are being produced for space," Lanphier said. "The only person who can change that decision is the President."

Sam Hoffman, manager of North American Aviation's Rocketdyne Division, said thrust of the *Atlas* engines has been upped to 380,000 pounds from about 360,000.

He said NAA also is proposing newer engines for the *Atlas* which will be simpler, have increased thrust and employ more advanced propellants.

Discoverer IX Misses In Polar Orbit Attempt

United States hopes to recover a 300 lb. capsule from outer space were dashed last week when the Air Force *Discoverer IX* failed to go into orbit.

Although the giant *Thor-Agena* vehicle made an apparently faultless takeoff, radar reports four hours later disclosed that it had failed to achieve orbital velocity and had disintegrated in the atmosphere.

The Air Force is yet unable to determine whether the 19.2-ft. second stage ever separated from the booster rocket. The entire Lockheed-built *Agena* was to go into a polar orbit and release the re-entry capsule on its 17th pass over the earth.

At the same time, a trail of aluminum chaff was to be released to provide a radar target. Waiting aircraft were equipped with a trapeze apparatus to "grab" the capsule's parachute and recover the package in the air somewhere off the coast of Hawaii. A satellite recovery ship also stood by in case the air recovery failed.

The booster rocket with a Rocketdyne engine was fueled with a liquid propellant known as "RJ-1," slightly denser than the standard kerosene-base rocket propellant.

The next attempt in the *Discoverer* program is expected in about a month.

Military Space Role Sparks Congress Debate

The role of the Armed Services in space loomed again last week as a bitter issue in Congress. The House approved 92-2 a joint resolution concurring with the Administration plan to transfer most of the Army Ballistic Missile Agency and the *Saturn* program to NASA. The resolution was sent to the Senate. Rep. Samuel S. Stratton (D-N.Y.) warned before the vote that the transfer would have "a disastrous affect" on the nation's security during the late 1960's and early 1970's.

House Democratic Leader John McCormack (D-Mass.) went along with the resolution but said the House Space Committee is planning to "look very carefully" into the Administration's division of space between civilian and military agencies. He said the Administration is not carrying out the true "intent" of the National Space Act in this area.

Stratton hit directly at President Eisenhower's contention that the Armed Forces have no business in space beyond a few thousand miles "Does anyone in this chamber really believe that the exploration and conquest of space do not have the most profound military importance?" He asked.

The resolution, in effect, would waive the 60-day waiting period required by law before the transfer could take place. The actual transfer of ABMA personnel and the some $100 million of ABMA facilities is not scheduled to take place until July 1.

news briefs . . .

• **Cape Canaveral**—President Eisenhower made his first inspection of this R&D facility Feb. 10 a few hours after missilemen successfully fired a streamlined "hot rod" *Thor*, but failed to get off a routine *Atlas* shot. The engines of the *Atlas* shut off automatically a few seconds after ignition and the bird escaped damage. The *Thor* had a cone-shaped aluminum fairing and a souped-up Rocketdyne fibreglass-wrapped engine. It was redesigned specially for space shots.

• **Washington**—Influential House Democrats launched a drive for greater defense spending. Chairman Carl Vinson of the Armed Services Committee called for "drastic sacrifices now" to catch up with Russia in missiles. Chairman Clarence Cannon of the Appropriations Committee urged Congress to disregard "specious" Eisenhower Administration claims that the U.S. is "still the most powerful nation on earth" and vote more defense funds. He said Russian missiles "unquestionably" could now wipe out every American city and SAC base within 30 minutes.

• **Washington**—Republicans charged that Democratic downgrading of U.S. retaliatory power was serving the Russian cause and might invite a Soviet miscalculation which could lead to war. One GOP Congressman declared that if the critical barrage continues there is a danger Americans some day might say "I'd rather be Red than dead."

Bossart Wins M/R Goddard Trophy

'Father of Atlas' picked by M/R editors for outstanding contribution to U.S. missilery. Award to be presented at Missile/Space Conference, Feb. 16-17 in Washington

by William J. Coughlin

When a young man in the Belgian Army decided in 1930 that he would prefer life in the United States, this country acquired another immigrant. The Belgian Army's loss was the U.S. Air Force's gain.

The young Belgain soldier was Karel Jan (Charley) Bossart, named this week by the editors of MISSILES AND ROCKETS MAGAZINE to receive the Dr. Robert H. Goddard Memorial Trophy for his outstanding contribution to the development of the Convair *Atlas* intercontinental ballistic missile.

The trophy is awarded annually to an individual, group or firm which in the opinion of the editors of MISSILES AND ROCKETS MAGAZINE made the greatest achievement in advancing the missile, rocket and space flight programs of the United States.

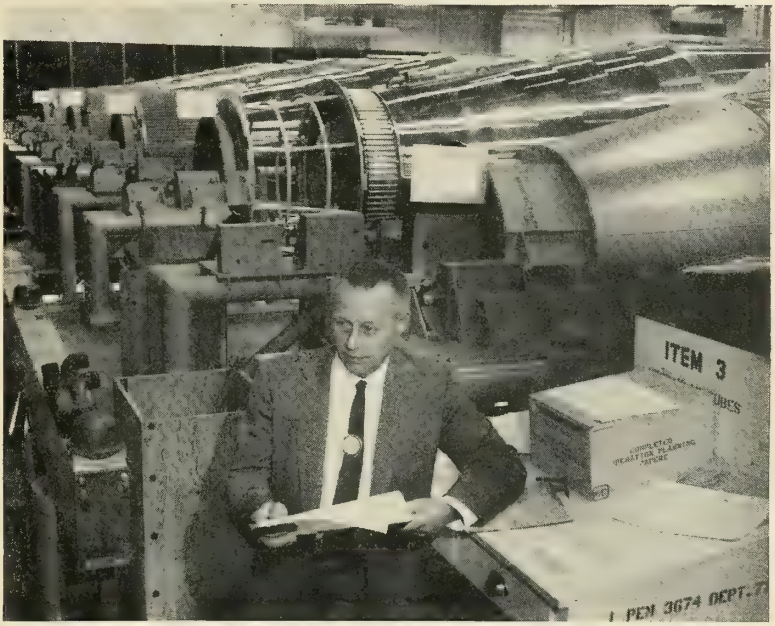
This is not the first award Bossart has received for his work on the *Atlas* program. In 1958, he was given the Air Force Exceptional Civilian Service Award. He also recently received the Institute of Aeronautical Sciences' Sylvanus Albert Reed Award for his contribution to the *Atlas* program. If this continues, he will have to add a wing to his San Diego home for the trophies.

Recently, Charley Bossart relaxed in San Diego in an armchair interview with MISSILES AND ROCKETS and said just exactly what you would expect him to say about his accomplishments:

"A lot of other people at Convair should get part of the recognition I'm getting." Then he grinned and added:

"My wife says my head is getting too big."

Looking back over the history of the program in a relaxed mood, the "Father of the *Atlas*," shook his head over the dark days which the project frequently encountered but when asked if he would willingly go through it again, responded: "Oh, sure."



"CHARLEY" BOSSART at *Atlas* production line in Convair's San Diego plant. Numbers on the big missiles have been masked for security reasons.

Then he thought a moment and added a phrase which, while not new to philosophers, still rings true: "Accomplishment is your best reward."

The project that was to become the free world's first intercontinental ballistic missile originated in 1945, just after World War II, when the Air Force called for study programs on ground-to-ground missiles. The German *V-2s* had made their impression. The Air Force wanted studies made of short, medium and long-range missiles. There were two long-range study programs. One later became the air-breathing Northrop *Snark*.

Convair—or to be exact, what was then the company's former Vultee Field Division—proposed a 5000 mile ballistic missile.

• **Invulnerability**—Primary reason for the belief in the ballistic missile was its relative invulnerability to defense.

"We thought the reason for going to a long-range missile like that, instead of a bomber, was that a bomber couldn't get through," Bossart remembers. "We didn't think an air-breathing job would get through any better than a bomber."

The company got an Air Force contract for study and development of the missile. There was no requirement for hardware. The chief structural engineer at the division was assigned to the program as project engineer. His name was K. J. Bossart.

It was touch and go for a while. One day Bossart was informed he would be project engineer; the next day, he was told it had been assigned

to someone else.

"That made me extremely unhappy," Bossart recalls, "but there was another switch and I got it."

Why did he want it so badly?

"I was intrigued by the possibilities," he says. "It was a challenge."

His appetite for missiles already had been whetted. As chief of structures, he had been involved in two surface-to-air missile programs, the *Lark* and Project *Bumblebee,* which later was to become the Navy *Terrier.*

It became immediately apparent to Bossart and the team he gathered around him that in probing so far into the unknown, some research hardware was necessary. One month after the contract for a pre-design study on a long-range missile was received from the Air Force, agreement was reached that Convair could build 10 MX-774 test vehicles.

• **Economy wave**—Then, in mid-1947, the military economy wave swept Washington. The Air Force had to decide which of its two long-range missile contracts to continue. The vote went to the *Snark.* The reason: the ballistic missile was too great a step in the state of the art.

With the funds remaining in the program, Convair would be allowed to build and fly three MX-774 test vehicles and then the program would end.

Altogether, the entire study project, including the three test vehicles, was accomplished at a cost to the government of only $2¼ million.

The three MX-774s were flown from White Sands, the first in July, 1948, and the last in December of that year. They were, indeed, advances on the state of the art.

The frame was an aluminum pressurized structure without stringers or ribs. Control was achieved by swiveling of the engines. Provision was made for separation and re-entry of the nose cone only.

"We had to jump from 200 miles to 5000 miles," Bossart says, "and it took a lot of imagination and new approaches."

Telemetering was a new art then and so was the principle of radio-inertial guidance. Everywhere along the line, Bossart and his team were pushing to and beyond the state of the art.

The first missile, Bossart remembers ruefully, was "nearly a flop." It went to 6000 ft. and then fell back. The second and third achieved beautiful launches but flamed out prematurely at 50 seconds, instead of the scheduled 75 seconds.

But the unconventional vehicles had pushed through all the critical regions where strength, rigidity and controllability might have presented problems.

• **Winner apparent**—Bossart and his crew were convinced they had a winner. But in December, 1948, they were out of business as far as the Air Force was concerned.

Fervent arguments convinced Convair management the program was worthwhile. The company put some of its own money into the project. Bossart and his associates pounded the corridors of the Pentagon trying to convince the Air Force of the worth of their weapon.

Somehow, Bossart's enthusiasm kept the 70 or so people on the team together during these lean days, even when many of them were offered better jobs elsewhere.

"They would come to see me," he recalls, "and say they had had a good offer from North American or Lockheed. I'd tell them I hoped we would be back in the missile business soon." Almost none left.

In 1950, the outbreak of the Korean war loosened the pursestrings in Washington and by 1951, the *Atlas* team was back in business. Breakthroughs on the nuclear warheads made it possible to scale the missile down until it was less than half of its original, unwieldy size.

In the summer of 1953, Trevor Gardner, then assistant secretary of the Air Force for research and development, called in Bossart and his team. If the *Atlas* were placed on a crash program, when could they come up with a missile?

Some compromises were made with the early specifications, particularly in regard to re-entry requirements. Against considerable opposition in the Department of Defense, Gardner pushed the crash program for the *Atlas.*

Western Development District, later to become the Ballistic Missiles Division, was set up to supervise the program. Bossart won't say so but this in itself was a considerable blow to the pride of the men who had fought so hard for the project in its lean days. Nevertheless, they pushed on and by December, 1954, design of the *Atlas* had been frozen.

"From then on, we went full speed ahead," Bossart says.

First hot test of the complete propulsion system was in mid-1956 at Edwards Air Force Base. First hot test of the full missile followed at Sycamore Canyon near San Diego and then came the first flight in June, 1957. First three-engined flight was accomplished in July, 1958.

There were further dark days when five successive *Atlases* failed. But there now have been 18 consecutive flights and it looks like the *Atlas* is on its way.

There are proposals for bigger and better *Atlas* weapons and bigger *Atlas* boosters for the space program.

And Charley Bossart? He is already looking ahead to deep space programs.

"The unknowns are even greater there," he says. To him, it's still the challenge that counts.

'Why' of Goddard Trophy

DR. WERNHER VON BRAUN, first winner of MISSILES AND ROCKETS magazine Goddard Trophy, in 1958 received the award from Wayne W. Parrish, President of American Aviation Publications.

The Dr. Robert H. Goddard Memorial Trophy is presented annually by MISSILES AND ROCKETS *Magazine in recognition of significant achievement in advancing the United States' rocket and space program. It is awarded to the individual, or group, selected by the editors of M/R on the basis of outstanding contributions, devotion, and leadership in the missile/space effort. Leaders in all areas of this effort—military, industrial, political—are considered in making the award.*

Selection for the Trophy is, we feel, a signal honor in a new science where failures make headlines and those who contribute to the successes often go unnoticed. It is fitting that it be named in honor of Dr. Goddard—the real pioneer in rocketry.

This is the third year the Trophy has been presented. The first recipient, in 1958, was Dr. Wernher von Braun, of ABMA. Last year's winner was Mr. S. K. Hoffman of Rocketdyne.

Army Facility Will Fight Interference

Five years and $40 million will be needed for environmental study by Army in southern Arizona; contract award is expected in near future

by Charles D. LaFond

FORT HUACHUCA, ARIZ.—Historically long overdue and, more recently, long delayed is the U.S. Army Signal Corps contract for an electronic environmental test facility (EETF) to be established here. Four teams remain in the running, headed by Vitro Corp., Pan American World Airways, Cook Electric and Sylvania. The contract award is imminent.

Since the Signal Corps specification for the program was specific in its requirements, approaches offered by the four teams are similar and proposed costs for the two-year, Phase-I task are roughly the same—nearly $25 million. (This amount has been funded since FY 1959.)

Essentially, the program at the EETF is divided into two parts: Phase I is to be approximately a two-year study of the effects and compatibility of electronic equipments in field use from squad level to division level within a corps. Phase II will be roughly a three-year extension of the program to study equipment operation in a whole corps within an army.

Results of Phase I testing will be thoroughly evaluated before starting the second phase.

• **Purpose**—Basic mission of the entire test program is to secure enough know-how concerning the use and interference problems of dense electronic-equipment populations to assure command control at all times. This is no small task, but the benefits of such a program will be far reaching.

The problem was first recognized—with fatal consequences by some—during World War II. A problem then, it is a nightmare now. We have simply run out of radio spectrum availability. Now we must learn to use more effectively the present allocations.

Fort Huachuca will be the brain center of EETF since it has been the electronic equipment proving ground for the Signal Corps since its reactivation in 1954.

In an isolated desert area against the foothills of a low mountain rim, it is located near the southeastern corner of Arizona, just a few miles from the Mexican border. The reservation itself covers 74,000 acres and has the use of an additional 35,000 acres of adjacent government owned land.

The entire test range will extend across southern Arizona from the Fort westward to Yuma Test Station (see map).

The area was chosen because its very isolation will permit establishing a controlled electronic environment and permit pinpointing any radio interfer-

MAP OF the electronics environmental test facility and drone ranges in southern Arizona.

ence from inside or outside sources. Terrain, local weather, and the existing limited interference from civilian radio and television stations were all considered.

Of primary concern will be the maintenance of a low-level of interference from these civil broadcast stations. To do this, there will be periodic cessation of operation at these stations. Cooperation with local and state authorities was sought and has been achieved. Immediate remedial action therefore can be taken to alleviate interference to or from these stations, depending on the situation.

Test frequencies used by the facility will be carefully monitored at all times.

• **Facilities**—The $25-million cost of Phase I does not include the range facilities and government furnished equipment.

A $12-million Drone Test Range will be turned over to the EETF prime contractor. Contracts already have been awarded for site preparation, building construction and equipment procurement. The various equipments needed will include photo, optical, microwave, telemetry, control facilities, etc. Many and different radar stations are being installed, plus a maze of landline communications to connect operational sites.

When completed, the EETF will have:

• A fully instrumented test range at Fort Huachuca and in a corridor between the Fort and Colfred Airfield (near Yuma).

• An electromagnetic environmental test area comparable to that found in a tactical situation.

Surveillance, drone and missile guidance, communications, and countermeasures problems can be thoroughly investigated as a result of this effort. (The new Republic SD-4 and Fairchild SD-5 high performance jet drones and their various sensory devices will be among the first test items.)

• **Future benefits**—The benefits from the successful completion of this program will be tremendous, not only militarily but for the entire country.

To better explain the problem, remember that in a modern division some 20,000 radio-frequency emitters will exist in a 60 square mile area.

Interference then is a problem. To further define it, the Army considers any interference of more than two seconds in length occurring more than once a minute as being significant.

Data obtained in the controlled environment of the test facility will be useful for reducing existing and predicting future interference, establishing equipment design criteria, providing operational concepts, and for frequency coordination and allocation.

Communications Satellite May Be in Orbit by End of 1960

Delayed repeater system will store messages on five special CEC recorders; other highlights of IRE Military Electronics Convention

Project *Courier,* a 500-lb. communications satellite with message capabilities comparable to a 500-page book, will probably be in an orbiting path between 600 and 700 mi. above the earth's surface by the year's end.

This was the opinion expressed by a high-powered panel of experts opening the 1960 Winter Convention on Military Electronics under sponsorship of the Professional Group on Military Electronics, Institute of Radio Engineers, in Los Angeles.

The delayed-repeater type satellite communication system will store messages on five special Consolidated Electrodynamics Corp. tape recorders for release upon command from ground stations.

The panel, consisting of James M. Bridges, director-Office of Electronics, Defense Research and Engineering, DOD; Paul Price, chief-Communications and Tracking Branch, Advanced Research Projects Agency; Dr. John R. Pierce, director-Research Electronical Communications Principles, Bell Telephone Labs; Dr. Hans K. Ziegler, chief scientist, Army Signal Research and Development Labs.; and Brig. Gen. John B. Bestic, USAF, Deputy Director, Communications-Electronics, Dept. of the Air Force, also indicated that Project *Echo*'s 100-ft. diameter balloon launches will soon be underway in line with the forthcoming *Courier* operations.

"Illumination" of *Echo* balloons will be accomplished by MIT's Lincoln Labs, plus facilities of GE, Bell and Cal Tech's Goldstone Lake facility in California's desert. Transmission of telephone messages between these sites will probably develop valuable experience for *Courier.*

Useful orbit for relatively simple communications satellites would be about 1000 mi. out from the earth, Dr. Pierce said, adding that it would require 20 or more satellites to establish a world-wide telephone system. The large number of relay vehicles would enable at least one to be available to all ground stations at all times.

The much-discussed "stationary" or "24-hour" satellite that would remain in essentially one spot over the earth's surface, would appear to be some time away, according to Dr. Pierce's remarks.

The concept is certainly feasible, he pointed out. But he paid present microwave equipment life is not yet satisfactory for "permanent" satellites; the all-important accuracy of positioning such a satellite has not been demonstrated; and there are still serious problems with directional antennas needed for radio transmissions from space vehicles.

The present major effort in Bell's Research Labs is development of a communications satellite, Dr. Pierce said, but more experience is needed with low-lying satellites before any high altitude projects are attempted. In this context, *Courier* would be considered a "low" communications satellite.

Bell Telephone's work in this area is paid for by an "adequately funded in-house program," he declared. If the concept works out as expected, there would be no reason for not having a privately financed communications satellite program. Such a system might be operated on the same general idea as leased telephone or telegraph lines.

The *Echo* balloons and accompanying test program are available to all who wish to participate, Dr. Ziegler noted. There will be many communications stations participating in the forthcoming tests, he added, and no limits of participants has been set.

Communications satellites should be used only for such purposes, Bridges commented, pointing out that "otherwise they are difficult to achieve." He noted further that the reliability of systems in the satellite have a direct bearing on the economy. If they are reliable, but only for a short time, it is difficult to find economic justification.

Picking up this line of thought, Dr. Pierce said that any communication satellite must have a reliability comparable to land lines, otherwise it cannot compete as an advanced or alternate system. Most probable and initial commercial use would be overwater message transmission where satellite advantages might outweigh often-troublesome transoceanic cables.

Carrying the reliability problem a little further, Dr. Ziegler singled out

the example of *Vanguard*'s two-year operation from solar cells and suggested a similar approach might be "scaled-up" for future operations with the result "close to an economic solution."

Gen. Bestic declined to comment on the status of military communications satellites other than the military "is never satisfied if it is doing its job."

The USAF officer said he "was speaking for the Navy, too" when expressing extreme interest in all aspects of communications satellite operations because of the services' "common need" and concern over "whatever man puts up, man can shoot down."

Developments with possible application to CW doppler techniques in precision guidance, navigation techniques and high-precision ranging were outlined in a paper by Dr. M. L. Stitch and Dr. H. Lyons of Hughes Aircraft Research Laboratories.

Work is not complete, it was pointed out, but the presentation considered possible use of an ammonia type maser as a portable frequency standard. Present quartz-type crystal frequency standards in best form have a drift error of about 3600 ft. per hour of running if installed in a deep space vehicle. The Hughes approach, if successful, will have an error of about 108 ft. per hour—a 30X reduction.

In comparison to piezoelectric materials, cesium beam or gas cell, the maser approach offers short term stability on the order of 10-12 as compared to an average for the others of 10-9 and requires simpler electronics than the C_s beam or gas cell. Its disadvantages are in long-term stability, machining, and the requirement for $N^{15}H_3$ ammonia at $400 per gram—although a gram lasts about 500 hours.

Results obtained from *Explorer VI*'s telemetry system, "Telebit," and a system description, were given by R. E. Gottfried, Space Technology Laboratories. Far from optimum, the system has performed well, he said. Pretransmission data processing would be a major improvement in future systems to limit data to only that significant to the user. This would eliminate redundancy and costs. Increases in space experiments and knowledge will produce space profiles in which certain information is more important at a given time than other data. Capability to measure quantities or conditions that do not exist can be eliminated. Telemetry systems should be designed for easy function shift by either earth command or a stored program.

Principles of PERCOS, a performance coding system, were enumerated by Dr. Ernest A. Keller, Chicago Military Electronics Center, and conference members were told an inter-industry organization has been proposed as a data collection center to aid users in the evaluation system for components, modules, instruments or methods.

CEC's tape recorder for Project *Mercury*'s capsule can record about one million cycles per lb. of weight and an equal amount per watt hr. Problems of determining materials compatible to oxygen environment of the capsule were outlined by CEC's G. W. Boyer. Ozone-creating motors had to be encapsulated, and other ozone-sensitive materials eliminated by test. Dacron and neoprene proved satisfactory in some applications, but thermoset plastics did not.

Photoscan Is Ideal for Surveillance

Answers problem of information retrieval from military drones; high resolution image can be transmitted long distances to provide film record almost instantly

A new electronic image-transmission system recently demonstrated should provide the answers to surveillance-drone data-acquisition problems. Many unique features and unusual operational characteristics of the system, called Photoscan, assure its use in future airborne military operations.

High vertical and horizontal resolution, almost instantaneous long-distance transmission, and a photographic-film ground record having extremely high quality overcome the major disadvantages of more conventional surveillance.

Developed by CBS Laboratories for combat surveillance, the transmitter portion employs an unusual scanner called a Line Scan Tube. T-shaped, the tube generates a brightness at least 30 times greater than possible with any conventional cathode ray flying-spot tube.

Even under such intense bombard-

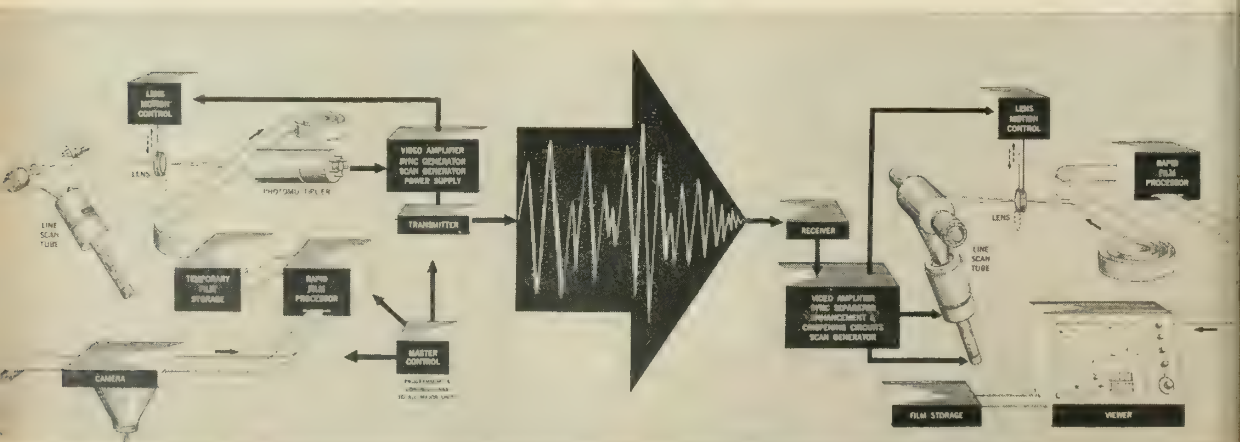
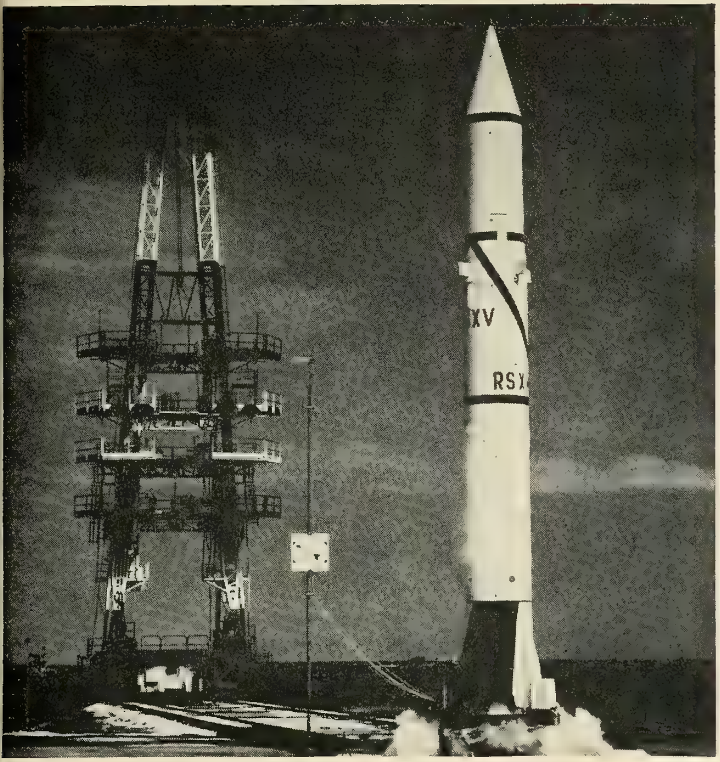
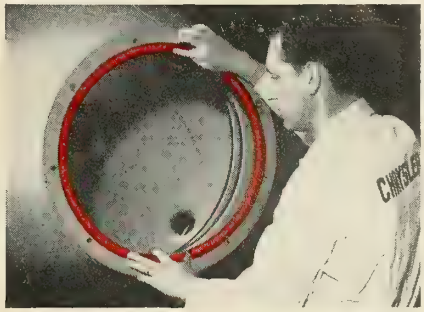


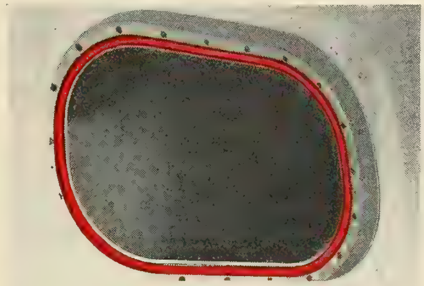
DIAGRAM shows the airborne scanner (left) and ground receiving equipment (right) which constitute Photoscan system.

Semper Flexibilis





Sealing the nose cone on the Army Redstone is an extrusion of Silastic. Silastic maintains a positive seal despite long periods of storage under load and adverse operating temperatures.



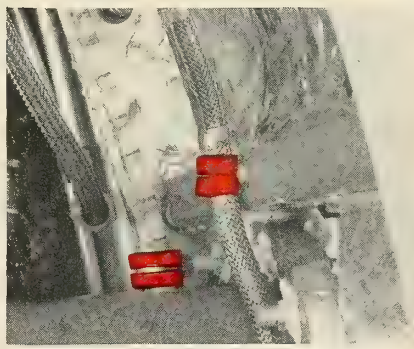
A similar application for Silastic, this time on the Army-developed Jupiter IRBM, another Chrysler-produced missile, is the seal on the angle-of-attack transducer compartment. Silastic was specified because it resists high temperatures encountered in re-entry.

SILASTIC SILICONE RUBBER seals missile sections; withstands -130 to 500 F

Till the moment when it separates during trajectory, the Army Redstone's warhead sits on a flexible seal of Silastic®, the Dow Corning silicone rubber. In fact, all sections of the missile are joined in this manner, to maintain pressure. Chrysler Missile Division engineers also utilize Silastic for many other applications, including ducting, wire bundle clamps and access door seals.

Silastic does these jobs so well because it offers reliability at all times . . . remains flexible even after long storage, at high skin temperatures, under compressive loads, in presence of ozone, cold, moisture. It is unaffected by weathering: 9 years exposure at a South Florida test station has failed to damage sample Silastic parts.

When your "bird is in the hole" and exposed to an environment of weathering, ozone, storage effects and a wide temperature range, you want reliability of rubber parts. Your rubber company supplier can engineer a part made of Silastic to suit your particular requirements. For more information, write Dept. 7602.



Chrysler Missile Standard Bundle clamps on both Redstone and Jupiter missiles are fabricated of Silastic. Electrical properties of this material are excellent.

If you consider *all* the properties of a silicone rubber, you'll *specify Silastic.*

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

ment, the new tube reportedly has an operational life of more than 1500 hrs. (A conventional tube operating under the same condition would die within minutes.)

All three services are interested in the system and at least one classified contract has been awarded for its further development and production.

A company spokesman also indicated the system probably would be tested shortly on the Fort Huachuca, Arizona, drone test range. The airborne equipment will be particularly applicable for use in the new SD-4 and SD-5 high performance jet surveillance drones.

Photoscan provides far higher definition than conventional television techniques. The latter has approximately 500 lines of resolution whereas the Photoscan picture has in excess of 10,000 lines, said CBS.

The sharpest television pictures today consist of 250,000 picture elements, whereas to meet the requirements of modern aerial reconnaissance, each Photoscan picture contains approximately 120 million picture elements, said Dr. P. C. Goldmark, CBS Lab president and director of research.

The new scanner processes the visual image obtained from an aerial camera or other sensing device and converts that image to an electronic signal which is then transmitted to another airborne relay station or directly to the specially designed receiving equipment on the ground. New electronic image-enhancement techniques are applied to the signal before reconstituting the original image for nearly instantaneous viewing and storage on film.

A key component of the system is the cathode ray tube developed by CBS. This tube contains a special phosphor-coated anode which spins at 1600 rpm within the high vacuum of the tube envelope. A fine electron beam from the tube continuously scans the rotating phosphor at a rate in excess of 10,000 times/sec.

The resultant luminous line is focused on film by a moving lens from which the light is transferred through a new type of optical system into a special photo-multiplier tube. The amplified video signal is then transmitted to distant receiving equipment where the image is reconstituted.

The anode drum rotates by means of an armature sealed inside the tube envelope, while the stator is mounted externally. The special bearings on which the armature spins, operate in the high vacuum within the tube. The bearings also employ a new technique in lubrication by solids, said the company.

The metal anode drum is surfaced with an extremely fast-decaying phosphor, applied by means of a process which minimizes phosphor grain size and provides high surface uniformity. The rotation of the phosphor-coated drum makes possible the rapid distribution and dissipation of heat created by the intense electron beam which, in a conventional tube, would lead to rapid deterioration of the phosphor.

Due to the rotation of the phosphor target, uniform grain distribution occurs in the transmitted picture.

Tiny Radiation Detector Called 1000 Times Faster

The unprobed secrets of nuclear forces are now being uncovered by means of a "solid-state ionization chamber" smaller than the head of a pin, a scientist at Hughes Aircraft Company has revealed.

The new device—an innovational radiation detector—has important applications in space exploration, military uses, nuclear power control, cancer treatment, industrial processes, basic nuclear research and other fields, according to the company.

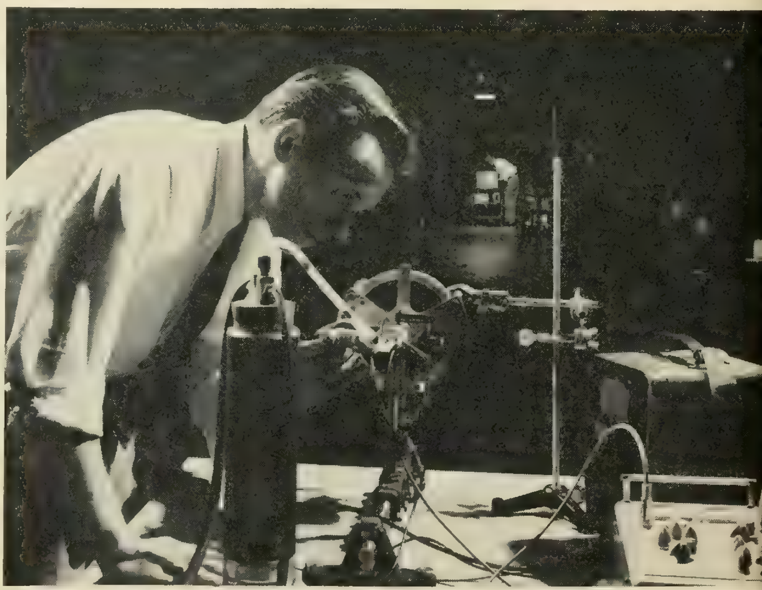
Dr. S. S. Friedland, a Hughes scientist, said that the detector measures the number and energy of atomic particles with far greater effectiveness than earlier detectors, is far less cumbersome, and costs less. It is essentially a tiny slice of doped silicon which when struck by a charged nuclear particle, emits a pulse which can be measured and analyzed.

One of the more important applications of the detector proposed by Friedland is in space exploration. A three-dimensional package containing hundreds or thousands of detectors, propelled hundreds of miles into space could transmit back to earth precise measurements of cosmic rays and the limits and nature of the Van Allen radiation belt.

Present methods use photographic plates inserted in the nose cone of a missile. Rays and particles penetrate the film and define their courses through the layers. After recovery of the nose cone containing the film, weeks and sometimes months must be spent in extracting the data from the plates. The proposed use of the Hughes detector coupled with an amplifier and telemetering devices would enable scientists on earth to immediately determine radiation measurements.

Hughes claims the detector can pick up particles 1000 times faster than previous models, and is so accurate it can analyze the energy of particles to less than 0.5% error, matching the performance of complicated equipment costing many thousands of dollars.

Tunnel for IR Radiation



BEHAVIOR OF infrared radiation in atmospheres vastly different from that of earth are studied in this Sperry Gyroscope Co. tunnel. Engineer in foreground measures efficiency of infrared detection device, his colleague adjusts device which emits controlled amounts of infrared light.

NBS Explores Structural Adhesives

Tensile tests conducted at temperatures down to —424°F on four types. Adhesives will have wide space vehicle application

An investigation into the low-temperature characteristics of four types of structural adhesives has been completed by the National Bureau of Standards for the Wright Air Development Center.

First developed about 15 years ago, these metal adhesives probably will be widely used in construction of future space vehicles.

Tensile tests were conducted at temperatures down to –424°F with filled epoxide, 3 rubber-phenolic, 4 vinyl-phenolic and 2 epoxy-phenolic compounds. The epoxy phenolics, both having a fiber glass supporting film, gave the best performance. The epoxide exhibited slightly less low-temperature strength, but faulty bonding apparently contributed to this.

Standard metal specimens were of 301 stainless steel and 2024T-clad aluminum alloy. Ten lap-joint panels (0.5 in. overlap length) were made by applying the epoxy-phenolic resin to the steel and the other adhesives to the aluminum sheets. Six samples from each panel were tested.

Each specimen was gripped 2 inches from the edges and stressed at a rate of 1300 psi until failure. The specimens were held at the test temperature for ten minutes before the load was applied.

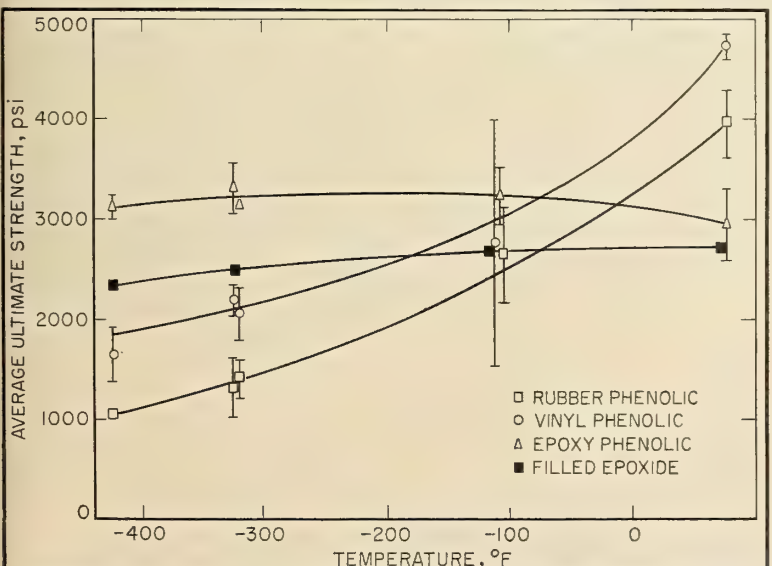
The average ultimate strengths of the four types at –424°F were rubber phenolic, 1065 psi; vinyl-phenolic, 1650 psi; filled epoxide, 2345 psi; epoxy-phenolic, 3120 psi.

Failures were classified either as adhesive or cohesive according to whether they occurred at the interface between the adhesive and adherend or within the adhesive and supporting film.

The rubber-phenolics and the vinyl-phenolics were predominantly adhesive failures while the epoxy-phenolics failed cohesively with about 30% occurring within the thickness of the glass fiber cloth.

The cohesive failure in the filled epoxy specimens appeared to happen only in the areas of effective bonding —which in some cases was as little as 70% of the lapped area. This could not be determined accurately because of the discontinuous nature of the bond.

None of the materials tested were specially formulated to withstand the test conditions involved.



ADHESIVE METAL bonds have a tendency to decrease in strength as temperature is lowered. Only epoxy-phenolics show slight increase.

Mellon Develops High-Strength Case Steel

by Frank G. McGuire

SAN FRANCISCO—A high-strength missile steel, developed specifically for use in rocket motor cases, has been unveiled by the Mellon Institute for Industrial Research. Perfected after only a 2½-month program, the steel—designated 4137 cobalt-modified—provides ultra-high-strength, good ductility, low notch-sensitivity, good welding characteristics, and easy formability.

The 4137 Co modified formula is based on AISI 4100 composition, modified by the addition of 1% each of cobalt and silicon. The objective was to attain a steel heat treatable to a uniaxial 0.2% offset yield strength level of 223.0 ksi.

Two principles of research were followed during Mellon's development program: experiments had shown that the chances of obtaining very high biaxial strength are greater in a low-alloy steel than in an over-alloyed steel; and the composition should be so balanced that a steel matrix heat treated to levels over 220 ksi and stressed, should distribute stresses evenly and yield homogeneously.

Nominal composition of 4137 is as follows:

Carbon	0.39%
Manganese	0.70%
Silicon	1.00%
Phosphorous	0.010%
Sulfur	0.010%
Chromium	1.10%
Molybdenum	0.25%
Vanadium	0.15%
Cobalt	1.00%

Describing results of tests on the steel, G. K. Bhat, of the Mellon Institute, cited a pressure vessel fabricated by the roll and weld method by Excelco Development Corp., Silver Creek, N. Y. This vessel, about 5'

long and 4½′ diameter, had a longitudinal seam and featured considerable notch characteristics. Despite the seam and notches, burst pressure was 1000 psig, and burst occurred in the parent metal at the aft closure. Fracture was not at a weld or notch location.

Notch sensitivity of 4137 was studied by comparison of tension tests on edge-notched and straight tensile specimens heat treated to several strength levels. Stress concentration ratio in notched specimens is K=5. The steel is not notch sensitive up to tempering temperature of 700°F. Between 700°F and 800°F, a slight tendency is noticeable, but not severe.

Work is continuing at Mellon, where cases measuring 5.7″ D, 27″ long, deep-drawn, with wall thickness of 0.035″ are being tested. It is believed that these will replace cases with 0.050″ wall thickness, resulting in a 20% weight saving.

The 4137 Co modified steel is now being commercially marketed by Universal Cyclops Steel Corp. (under the designation Unimach UCX2), and several other companies.

• **Technical papers**—Other papers presented at the Golden Gate Metals Conference included:

Materials and Fabrication Problems Associated with High-Strength, Light Weight, Homogeneous Pressure Vessels, L. L. Gilbert and J. A. Brown, Aerojet General.

Stress Corrosion of Steels for Aircraft and Missiles, E. H. Phelps and A. W. Loginow, United States Steel.

Fracture Toughness of High Strength Steel Pressure Vessels, G. R. Irwin and J. A. Kies, Naval Research Laboratory.

Metallurgical Tests as a Contribution to Pressure Vessel Reliability, Dean K. Hanink, General Motors Corp.

NASA Program and Findings on the Effect of High Stress Concentrations on High Strength Sheet Alloys, G. Epsey, NASA.

Fabrication Techniques Applicable to Rocket Motors, John H. Peters, United Aircraft Corp.

Important Factors in the Future Applications of High Strength Steels, Eugene P. Klier, National Academy of Sciences.

Current Practices in Ceramic-Metal Joining, Leon Lerman, Sylvania Electric Products, Inc.

Theory and Practice of Glass-Metal Sealing, Joseph A. Pask, University of California.

Ceramic-Metal Joining Problems in the Missile Industry, J. Patrick Sterry, Boeing Airplane Co.

Space Age Brazing, John Long and George Cremer, Solar Aircraft Co.

New Techniques in High-Temperature Brazing, N. Bredze, Armour Research Foundation.

The Hortonclad Process of Vacuum-Pressure Brazing, D. C. Bertossa, Chicago Bridge and Iron Co.

The Application of Electron-Beam Melting to the Processing of Materials, Charles Hunt, Temescal Metallurgical Corp.

The Application of the Plasmatron to the Processing of Materials, Ben Lohrie, Plasmakote Corp.

Growth of Compound Semiconductor Crystals, C. S. Roberts, Fairchild Semiconductor Corp.

Application of Shear Spinning to the Fabrication of Solid Propellant Rocket Cases, L. E. Zwissler, Aerojet-General Corp.

Spark Machining, A New Technique in Fabrication, D. L. Curtis, Japax America Corp.

Solution of Fabrication Problems by Explosive Forming, L. Zernow, Aerojet-General Corp.

In addition to these, numerous other papers were presented in specific fields bordering on metallurgy, such as electronics, chemical and petroleum processing.

Titanium Use in Missiles Rose in '59, Cost Dropped

Titanium products for missiles accounted for about 15% of the metal industry's total 1959 mill product shipment output, according to T. W. Lippert, Marketing Director for Titanium Metals Corp. of America.

In line with the increased usage, cost of titanium mill products was reduced to $7.22 per pound at the end of 1959, compared to a 1958 closing price of $8.66.

Lippert said missile applications of the metal will expand in 1960, but will not account for as much material as manned aircraft because of the relatively limited production runs of missiles.

Atlas, Titan, Sidewinder, Bomarc and space project *Mercury* are some of the programs using titanium products to capitalize on the metal's weight-reducing potential.

Protecting Moly

London—The government's Armament Research and Development Establishment at Fort Halstead has developed an "onion-skin" technique for protecting molybdenum from oxidation. It involves applying multi-layer electrodeposited coatings, alternately of 0.0002in. chromium and 0.0008in. nickel.

Coatings of 10 mil thickness tested at 1100° C. in an atmosphere of convected air are said to have given a life of up to 550 hr. It is believed that diffusion produces a coating similar to the Nimonic alloys.

"If we can move...we can whip 'em"

Cavalryman Phil Sheridan kept his maps in a pocket of his muddy coat. He read them like other men read their mail. "If we can move . . . something like this," he would suggest, with his finger tracing a bold path, "I think we can whip 'em." Sheridan, Lee, Stuart and the Civil War's other masters of mobility gave the world some classics of maneuver. Today their influence on U. S. Army tactical concepts is doubly significant. The Army's perimeter has become global. Threats must be met at any point on the compass. Movement in the Sheridan spirit is the answer: units that can move 4,000 miles in a day, and weapons specifically designed to move with them.

CHANCE VOUGHT
DALLAS TEXAS

What in Blazes Is High Temperature?

Fast-growing new field is lacking in logical nomenclature; expert proposes 'calorobics' as well rooted new word to cover the technology

by Harry B. Porter

CHINA LAKE, CALIF.—The advent of modern rocketry has given rise to a new concept of "high temperature." Where, a few years ago, temperatures of the order of 1000°F were considered "high," rocket design engineers are now thinking in terms of 6000° to 8000°F, and there is good reason to suppose that much higher temperatures will be employed in the future. Further progress in reaction propulsion will undoubtedly involve the development of higher-energy, hotter propellants.

Because of the rapid development of rockets and rocket materials, the problem of nomenclature has become increasingly difficult. A symptom of this condition is the recent rash of multiple adjectives and other polyhyphened monstrosities in the technical literature. This should not be surprising, inasmuch as several different and distinct fields of technology are involved, and there is no common frame of reference for many of the terms used. As an example, the term *high temperature* has different meanings for polymer chemists, metallurgists, ceramicists, and thermodynamicists, because they are accustomed to thinking in terms of different temperature ranges.

In the following paragraphs, a few of the more ambiguous and frequently misunderstood terms are discussed.

High temperature. The term high temperature is inherently vague, inasmuch as it represents a relative value. It is obvious, however, that high temperature no longer means what it once did. Just what *does* it mean? Does a ceramic kiln or the afterburner of a jet airplane—around 2000°F—come under the heading of "high temperature"? How about that generations-old symbol of the ultimate in heat, the blast furnace, whose 3000°F gases could be used to "cool" a modern rocket nozzle?

High-temperature material. The term high-temperature material is as indefinite as high temperature, and has the added disadvantage of being ambiguous. Do we mean a material that is produced at high temperature, a material *at* a high temperature, or a material that does not decompose at high temperature. "High-temperature-resistant material" may be a little more meaningful, but here again we are confronted with an ambiguity, because there is no indication of the manner in which the high temperature is resisted. Does the material merely tolerate heat, in the sense that it retains its own integrity at high temperature without affording protection to the underlying material?

Which brings us to a couple of other terms that have been badly mistreated in the last few years: "heat barrier" and "heat shield."

Originally, heat barrier was used to describe an imaginary barrier raised by aerodynamic heating at supersonic speeds, analogous to the much-publicized "sound barrier" of transonic flight. Perhaps because of the fact that the "sound barrier" turned out to be only a hurdle, a somewhat abortive attempt was made to introduce the term "thermal thicket."

A heat shield was formerly a structure designed to protect a re-entry body from destruction by aerodynamic heating. It may absorb heat for a time by virtue of its heat capacity, or dissipate heat through ablation or by other means.

Through usage, or misusage, heat barrier and heat shield have come to be used synonymously. The terms would suggest structures whose functions would be to prevent the flow of heat—in other words, a thermal insulator. Since no insulator is perfect, a more precise term would be heat retarder.

In the combustion chambers and nozzles of rockets, however, protection must be provided against the total thermal environment, which includes erosive and corrosive conditions. To be effective as a heat barrier, or heat shield, in the rocket context, the protective structure must function as more than just a thermal insulator. It must also act as a physical barrier to the impingement of combustion gases and solid particles upon the protected components, and be sufficiently heat-tolerant to maintain its own structural integrity long enough to provide protection for the required period of time. It is evident that neither heat barrier nor heat shield adequately describes such a structure.

Structures whose function is to get rid of heat through absorption, fusion, vaporization, endothermic decomposition, radiation, etc., would more properly be called heat dissipators than heat barriers or heat shields.

Calorobics—A step in the direction of greater conciseness and clarity of thought would be to provide a frame of reference by adopting a name for the field which comprises: (1) research, development, and application of materials to be utilized in confining heat or in controlling the rate of heat transfer at temperatures comparable to those of the nozzles and combustion chambers of rockets and; (2) the development and application of engineering designs aimed at the optimum utilization of such materials, especially in the rocket environment. The name should be short, meaningful and easy to remember.

"Calorobics" (*Kăl' ō rōb' ĭks,* L. Calor = heat + ob = against, in opposition to) is hereby suggested as a name for the field. The adjective would be calorobic. Thus, a material possessing sufficient resistance to high temperatures and erosive conditions to permit its use in the rocket environment would be simply a calorobic material. To be more specific, one may use such terms as calorobic insulator, calorobic heat dissipator, etc.

In addition to saving wear and tear on the dispositions of technical writers and readers, the adoption of the name *calorobics* would serve to give identity to a new field. Calorobics has developed too far, and has become too important in the total rocket picture to be contained within any one—or all—of its parent technologies.

About the author

Harry B. Porter is the Supervising General Engineer in charge of Missile-Components Material Engineering and Research at the Naval Ordnance Test Station, China Lake, California. He joined NOTS in 1948 after 18 years as a civil engineer with the Army Corps of Engineers. He was associated with the Navy's Sidewinder development program in its early stages.

Russia's Big Missile Bases

Exclusive M/R report pinpoints for first time 10 ICBM sites with 100-300 missile launch potential. IRBM bases total 30—many with missiles ready to strike Red China

by James Baar and William E. Howard

New information compiled by MISSILES AND ROCKETS indicates that today Russia has in combat readiness or under construction a minimum of 10 ICBM bases and 30 IRBM bases.

Moreover, the Soviets have missile plants in at least 17 cities—with perhaps as many as five turning out huge H-bomb-tipped *T-3* ICBM's. They also are believed to have eight special rocket training schools for both launch crews and engineers.

The exact number of big missiles Russia has ready to shoot now is not specified in this new information, which comes entirely from unclassified sources considered extremely reliable.

However, the number of bases—many of which have been in existence four years—and the reputedly vast rocket manufacturing capability plainly indicate the Russians are building up a global striking force that is much greater than admitted by the Eisenhower Administration.

Indeed, if the pattern for base building developed by the United States is applied (and there is no reason to believe the realities of logistic support are much different for the Russians), the 10 Red ICBM bases could hold from 100 to 300 missiles; and the 30 IRBM bases from 300 to 600 missiles with ranges from 700 to 1500 miles.

• **Also aimed at Red China**—As shown on the map, (p. 26, 27) ICBM bases are scattered from north of Moscow along a great arc dipping through the southern Soviet heartland and curving up to the northern Pacific Coast. From these bases missiles can be launched over the top of the world or across the Pacific at the United States. They also could hit Australia.

IRBM bases are most heavily concentrated in Western Russia and the northwest Siberian coast. There are 22 indicated in this region from which Russia could strike at Great Britain, all of Western Europe, North Africa and the Middle East.

TURN THE PAGE for a color map showing the location of Soviet missile sites.

The remaining eight deployed in the Far East are tailored to strike not only at Alaska, Japan, Okinawa and Formosa—but also at Red China. Bases at Omsk which has 3000-mile TCBM's, and Irkutsk are believed to be zeroed in on Peiping and other targets in Red China in obvious preparation for keeping Russia's restless Communist neighbors in line.

Because of complex strategic requirements, and undoubtedly for logistic reasons, the Russians are known to be "mixing" missiles at several bases. Some IRBM's are combined with ICBM's; so are test, R&D and satellite shots. Many IRBM bases—particularly those in the north—have antiaircraft missiles, too. And in the west, IRBM bases also house short-range tactical missiles (probably mobile) as well as air defense units for Moscow, Leningrad, Kiev and other big cities.

• **First-hand accounts**—This first, comprehensive picture of Russia's missile buildup stems largely from accounts of former slave laborers and captive engineers and scientists who have been permitted to return to their homes in Western Europe. Many of these returnees actually worked on missile base construction jobs, or in missile plants.

They were permitted to leave the USSR either through a bureaucratic slipup or deliberately. In any event, their individual observations have been pieced together in reports that have appeared over the past six years in German, French and Italian newspapers and military and technical journals—some within the past few weeks.

Plotting of the sites was made possible through translations of these reports especially for M/R by Bernard

Soviet ICBM Bases

Far East

Anadyr (64°43′N 177°28′E) on northeast coast less than 600 miles from Nome, Alaska. This base also is believed to have IRBM's and antiaircraft missiles.

Okha (53°40′N 143°E) on northern tip of Sakhalin Is. in the Far East. Has IRBM's within range of Japan and missile sea test facilities.

Komsomolsk (50°30′N 137°E) also IRBM's. Located in heavily industrialized Amur River valley about 1000 miles NNW of Tokyo and 1300 miles NE of Peiping.

Irkutsk (52°17′N 104°20′E) major rocket manufacturing center which is believed expanding present IRBM base to launch ICBM's.

West Central

Mid Kalinin (57°5′N 37°30′E) 90 miles north of Moscow possible ICBM site. Now has antiaircraft missiles.

Magnitogorsk (53°21′N 58°40′E) east of Ural Mts. in central Russia. Also has 3000-mile TCBM's which could hit Red China or Japan.

Alma-Ata (43°15′N 77°E) in south central Russia near China border.

Aralsk (47°20′N 62°5′E) near Aral Sea. Also believed to be satellite launching and missile test site.

Kapustin Iar (48°27′N 45°35′E) 60 miles ESE of Stalingrad. Also satellite launching site.

Murgab Oasis (37°36′N 61°50′E) about 200 miles from the Iranian border. Also thought to be seat of extensive Kara Kum desert missile range.


LONDON
PARIS
PEENEMUNDE
KURESSAARE
KOLA
MURMANSK
NOVAYA ZAMLYA
OSTROV KOLGUYEV
PRAGUE
SOVETSK
RIGA
SESTRORETSK
LENINGRAD
ARKHANGELSK
YELGAVA
LUGA
SEROC
BUDAPEST
MINSK
KALININ
MOSCOW
NOGINSK
BOBRUISK
ROSLAVL
KIEV
LADA
POLTAVA
ODESSA
KAZAN
U.
SAMARA
KYSCHTIM
KAPUSTIN IAR
MAGNITOGORSK
PETROPAVLOSK
OMSK
AFRICA
ARAL'SK
ALMA-ALTA

RUSSIA'S MISSILE BASES

Huge Soviet ICBM and IRBM capability is indicated in number and deployment of bases. Bases were plotted on map from unclassified source material gathered by Bernard W. Poirier, foreign information specialist. See accompanying story for precise coordinates.

▲ ICBM
IRBM
✱ TCBM (3,000 Mi.)
● EARLY WARNING
■ ROCKET TEST
ANTI-AIRCRAFT
○ SATELLITE LAUNCH
★ CITY

estimate may be conservative . . .

W. Poirer, a foreign information analyst. Prior to publication, M/R checked and re-checked this information with several highly qualified experts. They assessed it as "accurate." They felt that the number of bases listed is actually extremely conservative.

There are indications, through paved highways and railroad spurs which seem to lead nowhere, that the Russians could be building several more launching bases than pinpointed here.

The Russians themselves have never published the location of one of their bases, although their newspapers do report frequently on U.S. missile activity. Their reluctance to even name satellite launch sites appears to confirm the general belief that these are also ICBM sites.

• **The fourth command**—Russia's Army and Air Force are organized into a series of commands—Ground Forces (the Red Army); Air Forces (DA); and Air Defense. Western experts are convinced that all strategic missiles are under a fourth highly secret command.

This command may be headed by a former commanding general of artillery, Marshal Varentsev, who dropped from sight several months ago—just about the time it was pretty well established that all development of long-range missiles has been carried out under control of army artillery officials.

There is one minor disagreement on this latter point. The Institute for Strategic Studies, a Ford Foundation-sponsored group in England, reported in December that Soviet missiles have been organized under an "engineer general." ISS said this official also has control over "all factories in which nuclear bombs are manufactured, all testing sites, all factories in which rockets and guided missiles are produced and rocket and guided missile units."

Operational personnel for missiles, according to ISS, numbers 200,000 men. And ICBM's and IRBM's "have been in service since July, 1958." This agrees generally with M/R's findings.

ISS put the total number of Russian missile bases—with no breakdown as to type—at "about 100." This figure was challenged by American officials queried by M/R. They hold that the ISS report probably reflects figures "slanted" by British Intelligence for political reasons.

• **British overstatement?**—The major reason: Britain feels that if there should be a nuclear conflict, she would be caught in the middle and would die—win or lose. Hence, the British tend to overstate Russia's capability—to make the starting of an all-out war sound as foolhardy as possible.

Still, these U.S. officials do concede that much of the ISS report does agree with U.S. intelligence. To what extent or in what particulars, they cannot say, because of security.

It is axiomatic in every rocket tactician's handbook, however, that a nation's missile capability is only as good as the number of launchers it has to fire them from. Big rockets rolling off production lines are useless without bases. Thus, bases are one of the key factors in gauging Russia's missile potential—a consideration generally ignored in the current controversy over the Missile Gap.

Soviet IRBM Bases

Deployed toward Britain and Scandinavia

Kola (68°45'N 33°E) on Kola Peninsula near Murmansk. Situated in rugged terrain.
Ust-Taimyra—two bases—(76°15'N 99°E). Also radar and antiaircraft missiles.
Ostrov (69°25'N 48°29'E) on an island in Barents Sea.
Ozera (70°10'N 71°40'E) with radar post on north shore of Belyy Island.

Deployed toward Europe, North Africa and the Middle East

Lada (54°39'N 45°8'E) 35 miles NNE of Saransk on Insar River.
Kuressaare (58°18'N 23°33'E) on Saaremaa Island in the Gulf of Riga.
Minsk (53°48'N 27°21'E), Site is 20 miles WSW of site at Western edge of Pripet Marshes.
Kiev (50°27'N 30°31E). Within range of the central European gateway to Asia.
Seroc (52°35'N 20°55'E) 20 miles north of Warsaw, near junction of Bug and Narew Rivers. Only IRBM base in satellite country.
Riga (56°57'N 24°7'E). Also site of major missile production.
Kazan (55°47'N 49°E). A major industrial center.
Bobruisk (53°10'N 29°14'E) in Pripet Marshes 100 miles SE of Minsk.
Sovetsk (55°4'N 21°48'E) 30 miles NE of Kaliningrad.
Samara (53°10'N 50°6'E) about 70 miles west of Buzuluk.
Roslavl/Kirov—two sites—(53°58'N 33°6'E) southeast of Smolensk.
Yelgava—two sites—(56°39'N 23°43'E) about 25 miles SW of Riga at important rail junction.
Luga (58°45'N 30°3'E) about 80 miles south of Leningrad.
Odessa (46°30'N 30°45'E).

Far East—deployed toward Alaska, Japan, Okinawa and Red China

Anadyr (64°43'N 177°28'E) in inlet off Bering Sea less than 600 miles from Nome, Alaska.
Omsk (55°N 73°20'E) probably has 3000-mile TCBM's to hit Far East.
Okha (53°40'N 143°E) on northern end of Sakhalin Is.
Nikolaevsk (53°10'N 140°45'E) former naval base 20 miles from mouth of Amur River.
Korsakov (46°30'N 142°52'E) on Aniva Gulf at southern end of Sakhalin Is. 750 miles from Tokyo and less than 1500 miles from Okinawa.
Komsomolsk (50°30'N 137°E).
Mil'kovo (54°35'N 158°44'E) on Kamchatka Peninsula. Probably has 3000-mile TCBM's.
Irkutsk (52°17'N 104°20'E).
Terpeniye (49°20'N 143°45'E) near Poronaisk on Sakhalin Is.

• **Breaking the taboo**—Only recently was Central Intelligence Agency Director Allen W. Dulles reported to have told the Senate Space Committee that Russia would have 35 ICBM's "on launchers" by the end of June. His is the first actual reported reference to bases by an Administration official. Dulles is also said to have admitted that even this figure was an estimate, which could be on either the low or high side.

The CIA chief is further reported to have said the Soviets are expected to have between 140 and 200 ICBM's operational by mid-1961. And that the Russians probably have two factories producing ballistic missiles at present.

By June, this country is expected to have nine *Atlas* missiles in combat condition and by the middle of next year, if all proceeds on schedule, there will be four *Atlas* and one *Titan* squadron ready—totalling 45 ICBM's. The U.S. by then also should have three *Polaris* submarines capable of launching 48 1200-mile-range, nuclear-tipped missiles.

This makes a total of 93 strategic missiles under U.S. control vs. Dulles' estimated 140 to 200 Russian ICBM's. But if the Soviets risk war, *Polaris* missiles would not be involved in an ICBM strike to knock out U.S. missile and SAC bomber retaliatory capability. So, the Soviet ICBM advantage will, by excluding *Polaris,* remain about 4 to 1.

• **Expanding total**—The unclassified information made available to M/R indicates that the Soviets are expanding their ICBM bases today at a rapid pace. They are believed now to be constructing ICBM launchers in the Mid-Kalinin area 90 miles north of Moscow. ICBM launch pads also are reported to be going in at Irkutsk near the Red China border. This base already has IRBM's and is situated near Lake Ozbaikal on a high plateau.

The oldest, and probably largest, ICBM installations are located in central and south central Russia. One at Kapustin Iar, 60 miles east southeast of Stalingrad, is next to a spur of the Moscow-Astrakhan-Gudermes Railroad. This is also a satellite launching site where rockets can be fired eastward over the Caspian Sea.

A second combined ICBM-satellite launch site is at Aralsk near the Aral Sea. ICBM activity is reported at Alma-Ata to the east and to the south at Murgab Oasis, which lies 200 miles from the Iranian border.

Situated in the center of these three bases is the city of Tashkent (not shown on map), which is a missile manufacturing center and headquarters for a rocket training school. In addition, the city has one of the country's largest observatories (the sky is cloudless there most of the year) and is probably the prime satellite tracking and computation center.

Just east of the Urals is another ICBM installation at Magnitogorsk. This base also may have missiles pointed at Red China.

The three ICBM bases in the Soviet Far east—Anadyr, Okha and Komsomolsk—are reported to be combined with IRBM's. Anadyr, the northernmost, is less than 600 miles from Nome, Alaska. Komsomolsk in the Amur River valley, a heavily industrialized area, is about 1000 miles from Tokyo and 1300 miles from Peiping. Okha on Sakhalin Island is also a missile sea test site.

• **Eye to East**—Considerable activity is reported on the Kamchatka Peninsula stretching southward from Anadyr. Long-range missiles—possibly ICBM's but more likely 3000-mile birds for China or Japan—are going in at Mil'kovo, which is between two rugged mountain ranges.

Russia's Far East missile lineup also includes two more IRBM bases on Sakhalin—at Korsakov on the southern end and at Terpeniye Bay midway up the island. Both are near naval installations. A naval base at Nikolaevsk on the mainland, a short distance from Okha, also has been converted into an IRBM site.

In northwestern Siberia, IRBM's are spotted at four sites within range of Scandinavia and Britain. The most distant—on the Taimyra Peninsula—has two IRBM bases along with radar early warning facilities and antiaircraft missiles. The Ozera and Ostrov bases are both on islands and also tied in with air defense.

Soviet Rocket Training Schools

Riga *(advanced rocketry)*
Saratov *(ballistics and astronautics)*
Novosibirsk Kaluga
Sverdkovsky Tashkent Ufa
Irkutsk *(metallurgical and astronautical institute)*

Missile Plant Centers

Irkutsk	Kalinin	Kazan
Kharkov	Kiev	Ryninski
Riga	Omsk	Novosibirsk
Moscow	Leningrad	Komsomolsk
Kuibyshev	Saratov	Sverdkovsky
Tashkent		Ufa

Rocket Engine Development Centers

Irkutsk (STS)*, Ilmen area, Kalinin, Kazan, Riga (STS), Omsk (STS), Novosibirsk, Kuibyshev, Kiev (STS), Tomsk (STS), Kapustin Iar (STS), and Peenemunde (STS).

**Static Test Stand.*

• **Railroad launcher?**—A base on the Kola Peninsula near Murmansk had been believed to house strictly IRBM's. But there is speculation that the Russians may have used a railroad catapult here to fire the recent shots into the Pacific. The possibility has been raised that the vehicle was a prototype of the *T-4A Dyna-Soar* type boost-glide rocket.

In Western Russia new IRBM bases are reported under construction at Lada—near Kazan where there is another IRBM base—and at Kuressaare on the Estonian island of Saaremaa in the Baltic Sea.

Twin IRBM bases are located at Roslavl and Kirov north of Minsk and at Yelgava 25 miles southwest of Riga in Latvia.

The only IRBM base believed to be in a satellite country is at Seroc, 20 miles north of Warsaw, Poland. This base is within easy range of all European targets and RAF and SAC missile and bomber bases.

Bases clustered around Moscow and Leningrad presumably contain short-range ballistic missiles as well as IRBM's with London and Paris labels.

• **Plants and schools**—The pattern of Soviet missile activity emerges in the distribution of reported rocket plants and training schools, as well as test sites.

Irkutsk, Kalinin and Komsomolsk—ICBM bases—have manufacturing facilities. So do such IRBM areas as Kazan, Kiev, Riga, Omsk, Moscow and Leningrad. Moscow, of course, is a well known seat of technical learning with the National Academy of Sciences unquestionably supplying most of the design, engineering and scientific brainwork for the various programs.

Riga has one of the USSR's most advanced schools for rocketry. The Metallurgical and Astronautical Institute at Irkutsk is affiliated with the National Academy of Sciences.

It is considered likely that ICBM manufacture is conducted primarily at Irkutsk, Komsomolsk and Kalinin, while somewhat lesser operations are underway at Tashkent and Severdlovsky, which is north of Magnitogorsk.

Session Slated on Medical Electronics in Space Work

LONDON—The Third International Conference on Medical Electronics, to be held in Olympia, one of London's major exhibition halls, July 21-27, will include a session on medical electronics in space research.

Other subjects to be discussed include instrumentation for medicine and biology; isotopes and radiology; ultrasonics and microwave radiation; the respiratory system; the digestive systems, metabolism and biochemistry; the circulatory system; electronic aspects of sight, hearing and locomotion; and the motor and nervous systems.

The conference is being organized by the Institution of Electrical Engineers, Savoy Place, London, W.C.2., which is inviting papers from all over the world. Simultaneous translation facilities will be provided, and there will be an international scientific exhibition.

Recovery Phase Stressed in U.K.'s Man-in-Space Work

LONDON—Work is continuing on the "pyramid" project for a manned satellite at Armstrong Whitworth Aircraft, according to Dr. W. F. Hilton, head of the recently formed Astronautics Section of the Hawker Siddeley Advanced Projects Group.

Dr. Hilton discussed the project in a recent address before the Bristol Branch of the Royal Astronautical Society. He said he was currently concentrating on the recovery phase of the satellite programme.

The "pyramid" effort was first outlined at the B.I.S. Commonwealth Spaceflight Symposium last August.

Storables Stir Renewed Interest

In view of the industry-wide interest in storable propellants for large rocket vehicles, reported by M/R last week, we asked Aerojet-General Corp. to prepare a comprehensive report on these propellants. Aerojet, manufacturer of the Titan *ICBM propulsion system, has performed extensive research in storables.*

If Titan, *as many reports indicate, should be converted to storables, the missile would be modified substantially, including many changes in the propulsion system. Although the changes have not been spelled out, they would very likely include changing of all seals in the pumps, valves, etc., redesign of the propellant tanks and other modifications.*

A combination of nitrogen tetroxide oxidizer and a 50-50 UDMH-hydrazine fuel mix would nominally give Titan *a boost specific impulse of 288 sec. (1000 psia, shifting equilibrium, nozzle exit pressure 14.7 psia). The LOX/hydrocarbon combination previously used was about 300 sec. The additional propellant capacity, due to increased density of the storable liquids, is expected to compensate for the loss in specific impulse. Density impulse for the storable combination jumps to 348 sec., compared with 308 sec. for LOX/hydrocarbon.*

Since storability helps provide instant readiness, the most immediate application for storable propellants is in military systems. Proponents argue that the readiness factor eliminates a major advantage of solid propellants in weapon systems while maintaining most of the performance advantage of liquid propellants.

The same arguments are made for the use of storables to propel vehicles on the return trip to earth from space missions—a need that is bound to develop.

The author, Dr. C. M. Beighley, joined Aerojet in 1955 after eight years of rocket research and development at the Ohio State University Research Foundation, Purdue University Bell Aircraft Corp. and the University of Michigan. As principal engineer and head of the Research and Materials Department, Liquid Rocket Plant, at Aerojet, he is responsible for chemical and physical analysis to establish new processes and uses for materials.

by Dr. C. M. Beighley

The full impact of storable propellants upon present and future missile systems is just now beginning to be felt by industry. Some storable propellants formed the mainstays of early propulsion systems. But interest in these systems waned as the search for higher performance became more intense.

Liquid oxygen assumed a place of importance with solution of the problems associated with the use of a cryogenic oxidizer in engine components and ground handling equipment. But as new missile systems were proposed and system studies were undertaken, storable liquid propellant systems have once again received a good share of attention.

The problems associated with the use of storables are being solved, just as cryogenic handling problems were solved. In addition, some storables with very high performance characteristics are being investigated. One of the most promising areas appears to be that of boron compounds.

• **Pentaborane stir**—The greatest stir in the rocket industry is being caused by pentaborane (B_5H_9). Theoretical calculations—as well as limited small-scale testing—indicate exceedingly high specific impulse values for some pentaborane-oxidizer combinations. For example, the calculated performance of 98% H_2O_2 and pentaborane is 312-15 sec. This compares with 300 sec. for the conventional LOX-hydrocarbon combination.

A new concept in liquid propellant systems has evolved from consideration of two families of compounds as sources of boron nitride in rocket exhaust products. Boron nitride's theoretical high heat of formation makes increased rocket engine performance feasible by the use of boron and nitrogen compounds which yield hydrogen as a working gas in the combustion products, thus reducing the average molecular weight of product gases.

The two families of compounds, boron hydrides and nitrogen "hydrides" (ammonia, hydrazine, and hydrazine derivatives), are both ordinarily regarded as fuels. However, in the new concept, the boron hydrides behave as the fuels, and the nitrogen "hydrides" behave as the oxidizers.

Theoretical specific impulse values calculated for various propellants of these types range from 270 sec. for HEF-2 fuel and an oxidizer composed of hydrazine nitrate dissolved in UDMH to 347 sec. for tetraborane hydrazine. In those propellant systems containing carbon, sufficient oxygen is included in the oxidizer to give complete combustion to carbon monoxide.

Another system of interest involves the use of pentaborane or other boron hydrides with mixtures of ClF_3 and ClO_3F. It is postulated that BOF is formed in the combustion process, which is a gaseous product. The high theoretical specific impulse and relatively high bulk density of this system promise to warrant further investigation. Calculated specific impulse for 50% ClF_3 & 50% ClO_3F/B_5H_9 fall within the range of 288-301 sec.; higher performance may theoretically be obtained with different mixture ratios.

What is a "storable liquid propellant? The term has been rather loosely defined in the rocket industry. One definition is that a storable propellant is any that is liquid under normal ambient operating conditions, thus eliminating cryogenic liquids.

But a further refinement of the definition includes the idea that the propellant may be stored with relative ease in some type of fairly standard container without becoming contaminated or requiring constant care (venting, replacing seals, etc.). Safety in storage and handling are further considerations.

Thus the storable propellant is one

that does not have an excessively high vapor pressure at ambient temperature and is not incompatible with so many materials that it is virtually not capable of being contained in the practical sense.

• **The mission**—What jobs can storable propellants perform? Some of them are propelling an 8000-mile ballistic missile, a 200-mile ballistic missile, an air-launched ballistic missile, an air-to-air missile, a satellite booster, a manned space vehicle, a manned satellite vehicle, a launch unit for a moon vehicle and a second-stage boost vehicle.

Since each prospective propellant has a unique set of properties, candidates for the role may be rated as to their storability, performance, and suitability for particular applications. In evaluation, each of these items is assigned a value, then a weighting factor is applied to the sum of the values for each of the major categories. In this manner, comparative values for any number of propellants or propellant combinations may be obtained.

For missions in which pre-packaged storable propellants are desired, for example, the most important properties are chemical stability and low corrosion rate. Other factors might be low vapor pressure, high density, low freezing temperature, low toxicity, and low shock sensitivity.

In this case, the properties desired are dictated by the propulsion system requirements: instant readiness, ease of handling, long-term storage, wide range of environmental conditions, envelope limitations, and systems safety.

With a suitable choice of propellants, pre-packaged propulsion systems can be designed to be exceedingly rugged—unimpaired by rough handling in the field, and unaffected by a wide range of temperature conditions.

In pre-packaged air-launched missiles, aerodynamic heating does not impose severe limitations on the system. The propellants stored in the missile tanks act effectively as heat sinks to absorb the heat generated during flight. The pre-packaged propellants also eliminate the logistic requirement associated with topping the tanks due to boil-off.

• **Serious contenders**—The high performance attainable with the newer storable propellants, and the even higher performance predicted for those still in the research stage, makes them serious contenders for many advanced astronautical and weapon system applications.

The advantages of storable liquid propellant rocket engines may be summarized as follows: excellent performance, simplicity of engine design, instant readiness, high reliability, safety, missile mobility, long term storage, suitable for volume/limited applications, wide temperature-cycling capability, minimum of ground support equipment and maintenance, and low cost.

Many of these desirable features are directly attributable to the fact that most storable liquid combinations are hypergolic. The resultant engine designs, therefore, are quite simple and exhibit high reliability. Elaborate ignition and control systems are eliminated. With hypergolic systems, combustion is achieved instantaneously. Propellants burn but do not detonate.

As more potential uses for rocket-powered vehicles are explored, the requirements for the various types of missiles become more specific. One result of this evolution has been to place more emphasis on performance.

The newer storable propellants can theoretically deliver specific impulses ranging from approximately 300 to 340 lb.-sec./lb. (1000 psia and sea level), as compared to around 300 lb.-sec./lb. for liquid oxygen and jet fuels.

The military logistic requirements are more specific and realistic in present design concepts and permit a wider use of existing storable propellants. For example, requirements for cost-per-pound of propellant, the use of an existing liquid (such as an aircraft fuel), and an extremely wide environmental operating range are no longer limiting criteria.

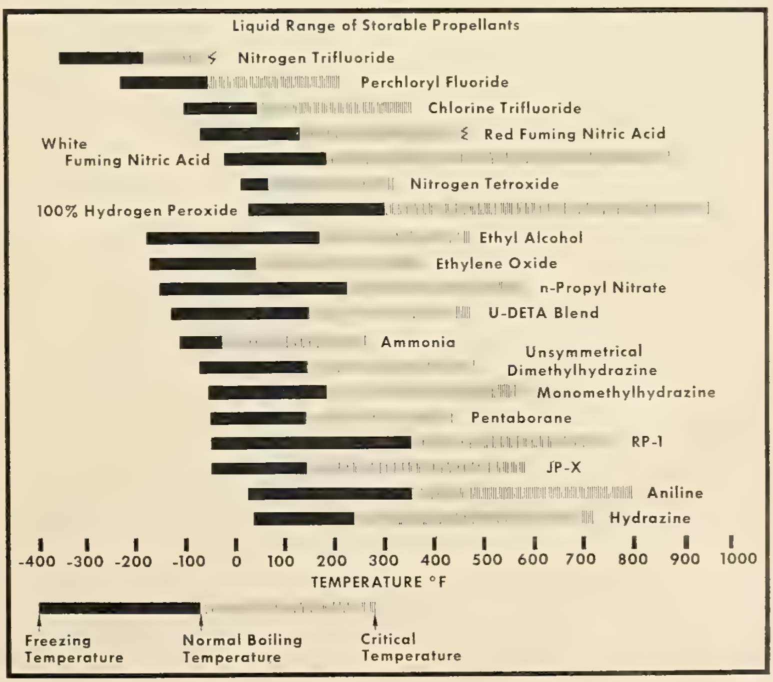
• **Relaxed requirements**—A change in thinking on these matters is particularly noted with regard to the operating temperature range requirement, which heretofore often demanded satisfactory missile performance over the range of temperatures from the arctic to the tropics. Today many missions are expected to be performed under a much more limited range of temperatures.

The missile may be maintained in a protected environment prior to launching—a silo, a submarine, or other type of permanent storage site—and the "field" conditions will not be so rugged as formerly.

The missile/space industry is finding that subsystems other than propulsion (such as guidance) are demanding controlled environments which are more stringent than those required by propulsion systems. Hence, controlled environments for pre-packaged missiles may be maintained in some cases by insulated shipping containers, refrigeration envelopes, or heating blankets.

Space missions present a whole new set of environmental conditions requiring new concepts for propellant storage facilities, particularly for those applications involving manned vehicles or long-term storage in orbiting space stations. Several storable propellant combinations appear to be particularly

Limits of the Liquid State



well suited to these applications.

Continuous research on storable propellants has produced not only a wide variety of oxidizers and fuels with a wide range of physical properties, but has also resulted in methods to alter properties of many compounds by use of additives, catalysts, or combinations of propellants so as to enhance their properties for rocket engines.

For example, if nitric oxide (NO) is added to nitrogen tetroxide (N_2O_4), the NO depresses the freezing point of N_2O_4 without reducing performance. A mixture of 77% N_2O_4 & 23% NO has a freezing point of –65°F. Without the NO, N_2O_4 would freeze at 12°F.

Greater progress is expected in this area of propellant improvement as more of the storable propellants are chosen for advanced missile systems.

The properties of an ideal storable propellant may be summarized as follows: high specific impulse, high bulk density, compatible with a variety of materials, stable combustion, hypergolic, broad liquid range, low viscosity, chemical stability, good heat transfer characteristics, low vapor pressure, thermal stability and non-toxicity.

Not all the criteria, of course, are met by each of the oxidizers and fuels classified as storable propellants, but a sufficient variety of these propellants exist, covering a broad range of the desired properties, so that a suitable choice may be made for nearly all applications. More research is required to develop a number of potential propellants for liquid rocket engines; however, increased effort to improve the state of the art of storable propellants is expected to produce the desired results.

Following are summaries of properties of common storable fuels:

• **Unsymmetrical Dimethylhydrazine (UDMH)**—The physical properties of UDMH approach the ideal for rocket applications. Its liquid range is broad; it is stable in long-term storage and under severe temperature and pressure conditions in rocket components; its cost and availability are satisfactory for a rocket propellant.

Extensive testing of this propellant in full-scale hardware has demonstrated that UDMH is easily handled without the use of special equipment. Industry-wide experience with UDMH has probably been more extensive than with any other high-performance fuel suitable for use with storable oxidizers.

• **Hydrazine (N_2H_4)**—Of the currently available storable fuels, hydrazine has the highest performance with all storable oxidizers. It is the most dense of the neat liquid fuels. The only physical property that limits its usefulness is its freezing point (+34°F). Hydrazine is the preferred fuel in uncooled engines for those applications where temperatures below 35°F are not encountered or can be compensated for.

In engines designed to avoid its explosive vapor phase decomposition, hydrazine can be used as a regenerative coolant because its heat transfer properties are not exceeded by any of the known storable fuels. Hydrazine has been demonstrated in full-scale tests and problems with its use have been defined. Further, it can be stored for long periods of time in pre-packaged propulsion systems.

• **Monomethylhydrazine (MMH)**—MMH has a broad liquid range and other properties favorable for long-term storage in pre-packaged systems. However, because interest in MMH as a rocket fuel is quite recent, its cost is relatively high and it is available only in limited quantities.

New manufacturing processes are expected to increase production and decrease cost in the near future. The performance of MMH, which is intermediate between UDMH and hydrazine, has been demonstrated in a number of full-scale tests. MMH does not have the detonable vapor-phase decomposition problems associated with hydrazine.

• **Mixed Amines**—Mixtures of amine-type fuels provide performance, density or physical properties that are not obtainable with the neat fuels. Experience with mixtures of hydrazine with UDMH and with MMH has shown that the vapor-phase problems of hydrazine are eliminated and that the performance is intermediate between that of the components of the mixtures. Some depression of the freezing point of hydrazine is also obtained with these binary mixtures, but ternary mixtures are required to obtain a freezing point at or near –65°F.

"Hydrazoid" fuel is such a ternary mixture. Only small scale tests have been made with this fuel.

Increased density can also be obtained by using mixtures of UDMH and diethylenetriamine (DETA). Although this two-component system does not give density values as high as the hydrazoid fuel, in full-scale tests the UDMH-DETA mixtures have been proved practical for current use. Viscosity data indicate that mixtures containing as much as 60% DETA are practical to temperatures as low as –40°F.

• **Ammonia (NH_3)**—Ammonia is readily-available, cheap, and has been tested extensively at full scale. From a physical property standpoint, if high vapor pressure can be tolerated, ammonia can be regarded as a storable fuel for pre-packaged systems. However, on the basis of performance or density, ammonia is not competitive with hydrazine or the hydrazine derivatives. It is not hypergolic with nitrogen oxide oxidizers unless lithium metal is placed in the fuel line just prior to firing.

Here are the properties of oxidizers:

• **Nitrogen Tetroxide (N_2O_4)**—Of the nitrogen oxide oxidizers, N_2O_4 is generally preferred to red fuming nitric acid (RFNA) and mixed oxides of nitrogen (MON). Its performance is high and its handling properties, cost and availability are favorable to its use in storable and pre-packaged propulsion systems.

Its major disadvantages are its high freezing point, 12°F, and vapor pressure. Extensive experience in full-scale tests has shown that values of combustion efficiency are obtained with little or no combustion instability.

• **Red Fuming Nitric Acid (RFNA)**—RFNA is preferred to N_2O_4 for applications in which low temperatures are encountered, or in which high density is an important factor. Like UDMH, the physical properties approach the ideal for a storable propellant. Its handling properties, cost, and availability are favorable to its use in storable and pre-packaged units. Extensive experience in full-scale tests with hydrazine, UDMH and other fuels has demonstrated that smooth combustion can be obtained at high levels of combustion efficiency. Corrosion is a problem, of course.

• **Maximum Density Fuming Nitric Acid (MDFNA)**—Experience with RFNA has been limited to acid containing no more than 22% of N_2O_4 (Type I_v). It has been shown, however, that the N_2O_4 content of the acid can be increased to 52%. Above this concentration a two phase mixture is formed; as N_2O_4 is added to the nitric acid, the density of the acid increases beyond the density of the components until a maximum density value is reached. This mixture is known as MDFNA.

For first-stage systems, volume-limited applications, and for conversion purposed, MDFNA may show increased mission accomplishment relative to neat N_2O_4 and RFNA.

The handling characteristics of MDFNA are similar to the standard types of red fuming nitric acid, except that its vapor pressure is higher due to the higher content of N_2O_4. Chemical

company forecasts are that MDFNA can be supplied as readily as the standard types of RFNA. No difficulties associated with its use are foreseen.

• **Mixed Oxides of Nitrogen (MON)**—Mixtures of nitric oxide (NO) with N_2O_4 are of interest because the NO depresses the freezing point of N_2O_4 without reducing its performance. In fact, NO has a slightly higher performance than N_2O_4 MON-15, which contains 15% of NO, has a moderately freezing point (–25°F), and its vapor pressure at 125°F does not exceed 100 psia.

In applications where higher vapor pressures can be tolerated, higher concentrations of NO can be used to obtain lower freezing mixtures. At the same time, there is an accompanying decrease in density.

MON, therefore, is the preferred N_2O_4-based oxidizer for applications in which a higher premium is placed on specific impulse than on density impulse, and where the pressures that accompany the desired amount of freezing point depression can be tolerated.

MON is similar to N_2O_4 in storability and is suitable for pre-packaged systems. Experience in handling and use of this oxidizer in engine testing is less extensive than with N_2O_4 and RFNA, but sufficient data have been obtained to indicate no serious problems should be anticipated in the development of propulsion systems with this oxidizer.

• **Hydrogen Peroxide (H_2O_2)**—With hydrides such as pentaborane (B_5H_9), the performance of H_2O_2 is attractive. The H_2O_2 (98%)/B_5H_9 system has a theoretical specific impulse 7.9% higher than the N_2O_4/UDMH system, but has a 14% lower bulk density.

The major limitation of H_2O_2, however, is thermal instability. Although it is regarded as a currently available storable oxidizer for some applications, because of its inherent thermal instability, tanks and other storage vessels must be vented to release decomposition products, preventing its use in pre-packaged propulsion systems at present.

In addition, the high freezing point of H_2O_2 prevents its use in applications where low temperatures are encountered. Low-freezing-point mixtures are known (for instance, with ammonium nitrate), but the addition of freezing point depressants invariably increases the decomposition rate and lowers the performance. Extensive testing has been conducted at small and full-scale levels.

• **Chlorine Trifluoride (ClF_3)**—ClF_3 is a storable oxidizer that can be used in pre-packaged propulsion systems. Its primary advantage is the large increase in bulk density and density impulse. The bulk density of the ClF_3/N_2H_4 system is almost 25% above that of N_2O_4/UDMH, although the specific impulses of these two systems are almost identical.

A number of metals, including stainless steel and aluminum, are compatible with it, due to the formation of passive fluoride films. Consequently, its handling problems are not a serious obstacle to its use, and its availability and cost will improve as production rises. Some full-scale tests have been conducted.

• **Perchloryl Fluoride (ClO_3F)**—When ClF_3 is used with carbon-containing fuels such as UDMH or MMH, an oxygen-containing oxidizer should be mixed with the ClF_3 to allow the formation of CO and CO_2, rather than the fluorides of carbon.

Perchloryl Fluoride can be added to ClF_3 for this purpose. ClF_3 containing less than about 40% of ClO_3F suffers a sharp drop in performance when used with UDMH. Because of its high vapor pressure and high coefficient of expansion, perchloryl fluoride is not a practical storable propellant by itself. In mixtures with ClF_3 its properties, except vapor pressure, are essentially masked by the ClF_3. Small scale tests with a number of storable liquid fuels have been conducted.

• **Bromine Pentafluoride (BrF_5)**—Bromine pentafluoride is a compound of wide liquid range that is even more dense than ClF_3. Because of its high density impulse it can theoretically provide a significant improvement in mission capability for some volume-limited applications. BrF_5 is a storable material that can be used in pre-packaged systems. Its handling properties are similar to those of ClF_3. Theoretical calculations show BrF_5/B_5H_9 to be a high performance system. To date no tests have been performed on this oxidizer at Aerojet-General.

Calculated Propellant Performance

Oxidizer	Fuel	I^*_{sp}	Weight Mixture Ratio, Oxid./Fuel	Bulk Density g/cc	Density Impulse
N_2O_4	N_2H_4	291	1.35	1.21	354
	MMH	288	2.17	1.19	343
	UDMH	286	2.59	1.17	333
	U-DETA	282	2.74	1.21	341
	DETA	278	2.85	1.27	352
	Ethylenediamine	280	2.75	1.24	346
	TMB-1.3-D	279	3.55	1.22	340
	B_5H_9	296	2.95	1.08	318
IRFNA	N_2H_4	278	1.52	1.28	357
	UDMH	272	3.15	1.27	345
	U-DETA	268	3.26	1.31	351
MDFNA	MMH	280	2.40	1.30	364
	UDMH	278	2.93	1.28	355
	U-DETA	275	2.98	1.32	364
	DETA	270	3.14	1.39	376
	B_5H_9	294	2.80	1.14	336
MON-15	MMH	290	2.20	1.18	341
	UDMH	288	2.64	1.16	332
	U-DETA	286	2.90	1.20	342
	B_5H_9	302	3.06	1.07	322
H_2O_2 (98%)	N_2H_4	285	2.00	1.25	357
	B_5H_9	312	2.00	0.996	311
	"HiCal"	294	1.85	1.13	331
ClF_3	N_2H_4	292	2.79	1.49	436
	MMH	283	2.96	1.43	404
	UDMH	279	2.97	1.37	382
	U-DETA	275	2.95	1.41	388
	DETA	267	2.93	1.47	393
	TMB-1.3-D	264	3.09	1.37	362
	B_5H_9	288	7.1	1.47	423
ClO_3F	N_2H_4	295	1.46	1.21	358
	UDMH	290	2.70	1.16	337
ClF_3+ClO_3F: 70/30	MMH	289	3.28	1.38	398
65/35	UDMH	288	3.70	1.34	386
BrF_5	N_2H_4	244	3.35	1.86	455
	MMH	235	3.60	1.77	415
	UDMH	231	3.68	1.70	392
	DETA	220	3.68	1.84	404
	B_5H_9	246	11.45	1.99	489
N_2H_4	B_5H_9	329	1.27	0.789	260

*P_c = 1000 Psia; P_e = P_a = 14.7 psia; shifting equilibrium.

Aerojet to Build *Able Star*, Bigger, Restartable *Able*

Engine will have start-restart capability and double burning time

Aerojet-General Corp. is producing *Able Star*, a larger version of the workhorse *Able* upper-stage rocket with start and restart capability at altitude. It is Aerojet's first contract as prime systems manager on a major space program.

Able Star has 2.2 times the propellant capacity of *Able* and thus has a burning time of more than four minutes, compared with about two for *Able*. Thrust is increased somewhat from about 7800 lbs. to more than 8000 lbs. as a by-product of increasing the area ratio from 20:1 to 40:1.

Propellants in the *Able Star* will be a hypergolic combination of unsymmetrical dimethylhydrazine (UDMH) and inhibited red fuming nitric acid (IRFNA), a switch from white fuming nitric acid in the *Able*.

The area ratio increase brings specific impulse much closer to the theoretical 276 sec. (1000 psia chamber pressure, 14.7 psia nozzle exit pressure) than was possible in the smaller *Able*. The pressure-fed propulsion system has a single regeneratively cooled thrust chamber.

The Air Force Ballistic Missile Division awarded the contract last fall but kept the facts classified until last week. The amount of money involved was not disclosed.

Aerojet's major subcontractor is Space Electronics Corp., a subsidiary of Pacific Automation Products, in Glendale, Calif., which is responsible for fabrication, checkout and launch services of the electronic systems.

In the contract, Aerojet is program manager of all phases of the *Able Star* vehicle, including control, analysis, design, fabrication, checkout, ground testing and flight testing. On the *Able*, Douglas Aircraft Corp. was prime system manager and Aerojet built the engine.

Able Star was designed for use with a first-stage *Atlas, Thor* or *Titan* booster. The design enables it to shut down and restart at altitude while maintaining proper attitude orientation during the coast period. For placing a satellite in an orbital path of 300 to 600 miles, the shutdown-restart capability makes a third stage unnecessary.

The new vehicle is now undergoing pre-flight rating tests at Aerojet's Azusa plant. The first vehicle will probably be delivered to Cape Canaveral for flight test within six months.

After it passes flight tests, *Able Star* will be used on Project *Transit*, the Navy navigation satellite program; Project *Courier*, the Army communications satellite; and other space programs. The two former projects are ARPA programs due to be turned over to the individual services this year.

Aerojet's Systems Division, directed by Marvin L. Stary, is responsible for the *Able Star* program. Seba Eldridge, division chief of technical staff, is program manager.

APL Researchers Produce Resonant Burning Study

PRINCETON, N.J.—A thorough analysis of resonant burning, an unexplained headache that has plagued solid-propellant rocket designers since the early days of World War II, has been put forth by three Johns Hopkins University scientists.

F. T. McClure, R. W. Hart and J. F. Bird of Johns Hopkins' Applied Physics Laboratory presented their findings in a paper delivered Jan. 28 at the American Rocket Society's Solid Propellant Conference at Princeton University. About 600 attended.

"Since nothing particularly mysterious has been introduced into the description," McClure and associates declared, "it would appear that appropriate studies of the component parts of this synthesis could lead to its verification and to a more adequate quantitative description of the phenomenon."

Resonant burning in solid rockets has been responsible for many failures. The harmonic reinforcement of sound waves within the chamber appeared to operate similarly to the familiar phenomenon of harmonic vibrations on a bridge or other structure—the reason why the military requires marching soldiers to break step.

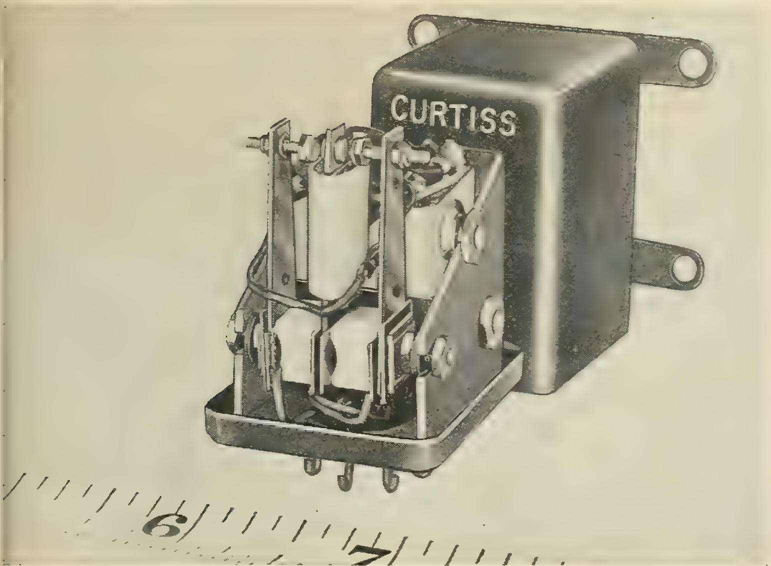
The Johns Hopkins scientists found that the thin burning zone in a solid rocket is generally capable of amplifying pressure disturbances at the surface. Thus self-sustaining oscillations take place when the gain balances the losses in the gas cavity.

The tendency to oscillate in a given cavity mode, McClure and associates found, is greatest for a web thickness such that the mode has an acoustic pressure maximum at the surface. The group reported considerable investigation by computer of the mode systems and the regions of instability.

The Johns Hopkins group said it had no clear explanation for the apparent efficacy of additives such as aluminum powder in suppressing resonance.

Mach 2 Sled Tests Minuteman

HIGHBALLING down the track at Holloman AFB, this Air Force three-chambered sled is capable of Mach 2 speeds. Propelled by Aerojet-General liquid engines, the vehicle accelerates at a force of eight to 10 g and has a total thrust of 114,000 lbs. It is being used to test the guidance system for ***Minuteman*****.**



Relay Features Isolated Switching

A new Curtiss-Wright STR Series relay provides a unique combination of features to meet missile requirements. The STR relay affords instantaneous resetting, isolated load contacts, preset T/D 20-180 seconds, voltage compensation, ambient temperature compensation, single pole double throw contacts, and is hermetically sealed.

The relay will reset the instant it is de-energized, providing the same time delay period for each succeeding cycle. This operational advantage has been achieved by using a special thermal element in conjunction with a pair of magnetic relays. This component combination utilizes the heating and cooling intervals to obtain the total time delay period.

Voltage compensation is provided for operation on 22 to 32 volts dc. Temperature compensation is over the range of –65°C to 125°C. The unit may be operated under high shock and vibration.

Power drain is less than 3 watts after the timing period, 10 watts during timing. Contact rating is 2 amperes at 28 volts dc resistive load. Approximate dimensions: 1-5.8in. x 1-3/16in. x 1½in. with bracket or stud mounting.

Circle No. 225 on Subscriber Service Card.

U.K. Tape Recorder

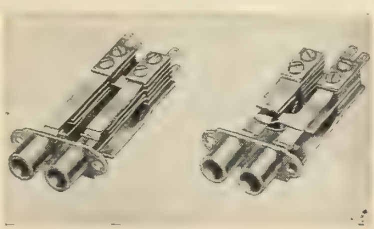
Royston Instruments Ltd., of Great Britain is manufacturing a subminiature magnetic tape recorder for handling flight data, primarily in missiles. The recorder measures 4½ x 5½ x 3″, and carries 500′ tape on spools in a reloadable cassette which also contains the purely mechanical take-up and supply spool drives and tape tensioning.

It can be supplied with tape speeds anywhere in the range of 30″/sec. down to 1/10″/sec. and records eight channels in line on a single head. Power consumption is about 5 watts. With an armoured steel cassette it weighs about 16 lb., but a solid light alloy cassette is usually strong enough for service even in missiles, and with this the total weight is reduced to 11 lb.

Circle No. 226 on Subscriber Service Card.

New Twin-Jacks

A long frame type "Twin-Jax," designed for high-quality communication equipment, has been developed by Switchcraft, Inc.



Frame is double width with two mounting ears on 1-3/8in. centers and the bushings (sleeves) are on 5/8 in. centers. The unit is available in two types: MT-388 (Military Type JJ-088) has a circuit shorting feature that is broken when a two-conductor plug is inserted into either sleeve, individually or simultaneously; MT-389 has three-conductor jacks interconnected, so that the circuit is broken when a plug such as Switchcraft No. 482 (PJ-051) is inserted in one of the Jacks.

Circle No. 227 on Subscriber Service Card.

Fluorinated Elastomer

Significant improvement in workability of a highly-fluorinated elastomer that is rated for service above +400°F and resists corrosive chemicals has been announced by Minnesota Mining and Manufacturing Co.

The firm will continue to use the name "Fluorel" KF-2141 Brand Elastomer on the product, introduced a year ago, although the new version has a Mooney scorch rating almost three times that of the original product—which is in the ideal range for rubber processing. It provides a fast cure with good heat aging quailties. The synthetic retains all other characteristics including low compression set after curing.

Circle No. 228 on Subscriber Service Card.

Orbital Mass Spectrometer

Consolidated Systems Corp., a subsidiary of Bell & Howell/CEC, has begun prototype testing of a miniature mass spectrometer to be placed in orbit within a satellite by NASA in 1961 to measure elements of the exosphere.

The double-focusing instrument will

be able to accept particles from wide hemispherical entrance angles and will have an energy spread of ±12 volts. It can measure ions, molecules, atoms, and free radicals to be encountered by the 35-in. diameter satellite in the region between 150 and 600 miles above the earth.

Circle No. 229 on Subscriber Service Card.

Strainer Gage Adapter

The SGA-100B Strain Gage Adapter, produced by the Ramapo Instrument Company, Inc., makes possible precision indicating, recording and controlling with strain gage transducers by utilizing equipment readily available in most installations. All necessary circuitry is included for the read-out of any strain gage type flow, pressure, weight, or force transducer on self-balancing dc millivolt potentiometers or recording oscillographs of suitable sensitivity.

Circle No. 230 on Subscriber Service Card.

Dial Groove Gages

Instant, accurate readings of internal groove dimensions permitting inspection without removing the work

from the machine and without using a micrometer are now possible with the new, economical line of E-Z Dial Groove Gages being introduced by Maxwell Industries, Inc.

Maxwell's lever action and dial indicator provide a measuring range from .2in. to 1.6in., with the small dial reading to the nearest hundredth of an inch and the large dial hand indicating the nearest half-thousandth of an inch. Each gage has an approximate range of .4in. in the smaller sizes while the larger sizes have a range of .8in. The unit reads accurate to fractions of .0005 in.

Circle No. 231 on Subscriber Service Card.

Two-Way Radios

Motorola is further expanding its extensively transistorized line of MOTRAC two-way radios with introduction of a 100-watt unit to operate in the low band (25-54 mc) frequencies.

The addition gives Motorola a complete line of units for operation in both low band and high band (144-174 mc) frequencies. Besides the new 100-watt unit, the company manufactures 25-watt and 50-watt models in low band, and 30-watt, 60-watt and 80-watt models for operation in the high band frequencies.

Like the other models, the new 100-watt unit will accommodate either positive or negative vehicular battery ground polarity.

Circle No. 232 on Subscriber Service Card.

Platinum Coating

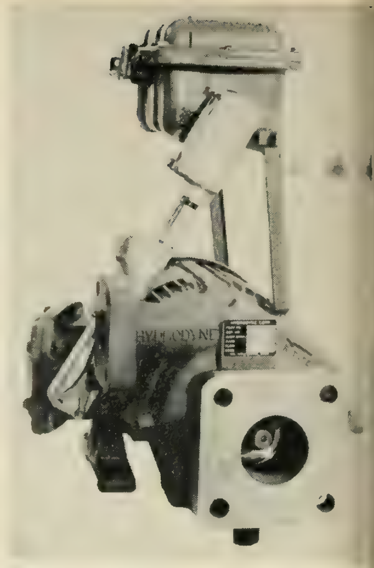
Using a technique developed by the Mond Nickel Co., Ltd., of Great Britain, the Baker Platinum Division of Englehard Industries Ltd. is now coating unglazed ceramic bodies with a continuous layer of platinum. The metal is applied in a liquid form, then fired to burn away the vehicle and bond the metal to the surface non-porous layers 0.005-0.01" thick can be applied and protect the refractory from corrosive agents.

Circle No. 233 on Subscriber Service Card.

Cryogenic

Hydrodyne Corp. has announced a line of utility pumps for ground support and test stands using cryogenic and other fluids.

The units are close coupled to an electric motor and have a range to 1500 gpm at differential pressures to 500 psi. The pump illustrated is 150



gpm with 20-foot head rise; 6-foot suction head (NPSH); 2½-in. suction; and 1½-in. discharge.

Circle No. 234 on Subscriber Service Card.

Microwave Absorber Bar

Radite No. 75, a new microwave-absorbing plastic, is designed for use as both coaxial and waveguide terminations and attenuators. It can be turned bored, tapped, drilled, threaded or milled just like a metal; and it is rigid, non-porous, and allows working to fine

tolerances. Radite No. 75 is available in stardardized 12in. bar stock, (round ½in. to 2-1/8in. square: ½in. to 2-3/8in), and comes with detailed machining instructions. It also may be poured or moulded to any configuration and size desired as a special order item.

Circle No. 235 on Subscriber Service Card.

Pneumatic Programmer

A new pneumatic program transmitter with interchangeable cams offering a choice of 1, 8, 12, 24-hour and 7-day cam drives has been announced by the Weston Instrument Division of Daystrom, Inc.

The programmer—designated as Model 7002—handles one or two transmission systems, transmits a 3-15

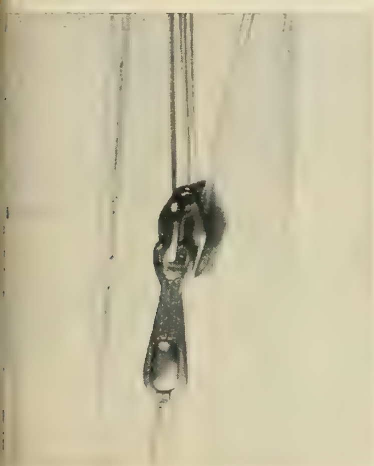
psi pneumatic signal, and can be used with single or double cams. The unit is supplied with universal mounts—flush or surface—and encased in a dust and moisture-resistant metal cabinet. The case features a flush latch handle, entirely eliminating front projections. A door stop limits opening swing to 135°.

Circle No. 236 on Subscriber Service Card.

Teflon Zipper

The Zippertubing Company has perfected a teflon closure of "Z-Trac" design, the first zipper of this type to be marketed. It is designed for closures that must submit to extremely high-temperature conditions.

The Zippertubing Company is offering the Z-Trac closure on its ALAS



and ALSR high-temperature and chemical resistant Zippertubing and on the all-teflon jackets. On the all-teflon jackets, the Z-Trac is sewn with teflon-coated glass thread to a 6 to 10 mil sheet material of teflon-impregnated glass cloth. A pressure-sensitive tape can be heat-processed over the stitching to seal needle holes if liquid oxygen, red fuming nitric acid or similar agents are used around the cable jacket.

Circle No. 237 on Subscriber Service Card.

Pressure Transducer

Dynisco, Inc., announces development of new high-frequency response differential pressure transducer Model PT 69. In this model both corrosive and conductive media can be applied to either side of a single diaphragm.

The transducer is fully compensated for temperature effects through the range of —65 to 300°F and is available in both uni-directional pressure ranges from 0 to 10 psid, to 0 to 3000 psid and bidirectional pressure ranges from ±5 to ±1500 psid. It measures 2½ x 2½ x 2¼ in.; total weight is 17 ounces.

Circle No. 238 on Subscriber Service Card.

Video Receiver Testers

A new team of microwave components that can provide an automatic testing system for crystal video receivers have been developed by American Electronic Laboratories, Inc.

The system incorporates a circularly polarized horn, high pass filter and a band pass "Waffle Iron" filter and waveguide switch. The switch permits disconnecting the antenna, and connecting an impulse generator, thereby injecting an artificial signal to test the receiving equipment and crystal in particular.

Circle No. 239 on Subscriber Service Card.

Vacuum Furnace

Marshall Products Co. has announced availability of a new high vacuum furnace, known as the Model 58-HD, for making hardness tests at temperatures up to 3000° F.

Heating element is a cylinder of sheet molybdenum 3 in. I.D. by 12¾ in. long. The element and its surrounding radiation shielding is provided in a single unit assembly for easy removal and access to the assembly and to the interior of the plated tank for cleaning and polishing.

Circle No. 240 on Subscriber Service Card.

new literature

SILICONE PRODUCTS. A 1960 guide to General Electric's complete line of silicone products is now available in an eight-page illustrated bulletin. Listing major product uses and benefits, this publication features GE silicones for: antifoam and release agents, lubricants, paper release, cosmetics and polishes, masonry water repellents, paint and paint additives, textile finishes, and electrical insulation. Another section is devoted to silicone rubber, including liquid RTV (room temperature vulcanizing) silicone rubber compounds.

Circle No. 200 on Subscriber Service Card.

THICKNESS TESTERS. Two portable thickness testers, Audigage Model 5 and Model 6, are detailed in an eight-page Bulletin A-200 available from Branson Instruments, Inc. Their ultrasonic gages permit measurement of thickness from only one side of a wide variety of materials—metal, glass, plastic—by relating a variation in thickness to the change in resonant frequency. An Audigage will detect laminar flaws, and check for corrosion loss. It is often used on pressure vessels, piping, storage tanks, boiler tubes, ship hulls and bulkheads, hollow forgings, extrusions, castings, as well as large plates and sheets.

Circle No. 201 on Subscriber Service Card.

TIME SEQUENCER. Magnetic Amplifiers, Inc. has made available an eight-page color brochure on a Static Time Sequencer which it says represents the newest development in solid-state magnetic switching. The Time Sequencer is a self-contained programmer which provides control/power signals for automatically performing test operations, such as missile countdown, in sequence. The equipment is also applicable to automated industrial process control.

Circle No. 202 on Subscriber Service Card.

BALL BEARINGS—A 140-page "Design and Purchasing Manual" on miniature and instrument ball bearings has just been published by New Hampshire Ball Bearings, Inc. and is available to qualified engineering and purchasing personnel. Complete specifications on 370 standard New Hampshire bearings from 1/10 to 5/8 in. OD are included, as well as 22 bulletins discussing factors in bearing life and operation.

Circle No. 203 on Subscriber Service Card.

ZIRCONIUM. A Zirconium Fact File in one package is being issued by the Zirconium Assoc. The Fact File will contain technical data, application and available forms of this unique metal as information is developed and compiled by manufacturers and fabricators. Data and sources of supply of zirconium for executives, technical and research personnel engaged in chemical processing, electronics, automotive, aircraft, missiles and other fields are given.

Circle No. 204 on Subscriber Service Card.

PHENOLIC LAMINATES. TRC, a new high-strength reinforced phenolic laminate which withstands temperatures in the 1000°F range without blistering or delaminating, is described in a bulletin published by Riverside Plastics Corp. The bulletin gives temperature vs. time data on flexural strength, flexural modulus, tensile strength and edgewise compression.

Circle No. 205 on Subscriber Service Card.

MAGNETIC PERFORMANCE AND DESIGN DATA—Magnetic Metals Company has available a 24-page Bulletin C-5 giving extensive design data, test data and magnetization curves for centricores (toroidal cores wound from thin magnetic tapes), stamped ring cores (made from laminations), and precision die-cut DU-laminated cores. Also included is data on Super Squaremu "79" Centricores for magnetic amplifier applications.

Circle No. 206 on Subscriber Service Card.

"MISSILES AND ROCKETS magazine is particularly valuable to us as it helps anticipate new and future trends through its concise technical news coverage." Fred R. Youngren, Manager, Raytheon's Aeromechanical Branch. In the picture above, Mr. Youngren (left) explains to Hal Gettings (center) of the editorial staff of Missiles and Rockets, the Raytheon thermal shock test process for ceramic radomes. It is through tests such as these that improved radomes have been produced to meet the requirements and conditions demanded by higher and faster missile flight.

WHO

lark C. Abt (left), Manager of Raytheon's Advanced Sys-m Studies Section and a regular reader of Missiles and ockets magazine, discusses some of the problems of anti-allistic missile defense with M/R Editor Hal Gettings. This articular section of Raytheon is working on the design and nalysis of systems to detect, track and intercept threatening ehicles from sea, the atmosphere and space. This program a natural outgrowth of Raytheon's extensive studies of ir defense by means of surface-to-air and air-to-air guided nissile systems.

"Even when a component is developed to a fine point, there is still a problem of extending the *state of the art*. The weekly issues of Missiles and Rockets keep us posted on the latest achievements of other companies in the missile/space field." Bertrand E. Chatel (left), Gyro Section Manager.

(above right) "High power output in a small reliable package is a basic requirement for electrical power units. Missiles and Rockets continually provides us information in related areas of engineering." John V. Kelly (left), Head of the Engineering and Mechanical Design Section.

READS MISSILES AND ROCKETS?

Well, for example . . .

TOP ENGINEERS AT RAYTHEON

Raytheon's Missile Systems Division has achieved outstanding success in pioneering and producing major missile systems. Two of these have been for the U. S. Navy air-to-air Sparrow III and the U. S. Army ground-to-air Hawk. These achievements, conclusive proof of unlimited capabilities, received their chief impetus when a Raytheon-developed guidance system installed in the Navy's experimental Lark achieved history's first successful interception in 1950 and first destruction of an airplane by a guided missile in 1951.

Much of Raytheon's success in guided missile systems since 1944 is credited to the tight integration of systems and component engineers. Close liaison of these groups provides systems engineers with rapid assessment of potential advances in "state of the art" of components and circuits, and also gives component engineers early indication of future requirements for meeting the needs of new, more complex missile and space systems.

Raytheon's Gnat gyros, for example, were first in the field, have been continuously refined, and now are mass-produced. Thermal effects of ever higher supersonic speeds are continuously being met by newly developed ceramic radomes—the largest being 4 feet long, 15 inches in diameter, and weighing 90 lbs. Highly reliable Electrical Power Units (EPU's) have been compacted into the smallest of spaces.

The further ability to carry these and other developments through flight test and into quantity production has resulted in the present top performance and high reliability for Raytheon's Hawk and Sparrow III missiles.

Experience of accomplishments in the broad field of missile and space sciences has promulgated study and development programs in solar energy conversion, ion propulsion, very-long-range ICBM tracking and identification radar, infrared missile applications and range instrumentation systems. Parallel advances also have followed logically, with studies of AICBM systems and investigation of means for defense against satellites.

TELL YOUR PRODUCT OR CAPABILITY STORY TO 29,000 MISSILE TECHNICIANS ... PAID SUBSCRIBERS ... THROUGH THE PAGES OF MISSILES AND ROCKETS MAGAZINE—THE TECHNICAL/NEWS WEEKLY OF THE MISSILE/SPACE MARKET.

M/R

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

Five-hundred prime contractors won $5,173 million—or 99%—of contracts of $10,000 or more awarded by the Department of Defense for experimental, developmental, test and research work in Fiscal Year 1959.

The total value of awards for such work in FY '59 was $5,246 million, compared to $4,077 million in FY '58.

North American Aviation, Inc., was at the top of a list of the 500 issued by the Office of the Secretary of Defense. The company was awarded $567 million during FY '59—10.9% of the total.

Lockheed Aircraft Corp. was second, with $511 million (9.8%); General Electric Co. third, $395 million (7.6%); General Dynamics Corp. fourth, $313 million (6.0%); and The Martin Co. fifth, $284 billion (5.5%).

• **'Spread' demanded**—The report was issued by the Pentagon as pressure built up among some key congressional Democrats for a bigger "spread" of defense R&D contracts. They cited figures showing that large firms are getting about 97% of all defense R&D funds.

A statement accompanying the Defense Department list did not give a total figure for awards to small business firms. It noted only that of the 397 business concerns on the list, 142 or 36% were small firms.

Besides the 500 listed contractors, the Department said, there were 1,251 business and non-profit concerns that received prime contracts of $10,000 or more, making a total of 1751 contractors in all. Of this total, 287 were government and non-profit organizations. Of the remaining 1464 contractors, 31 were foreign concerns, 589 were large U.S. business concerns, and 844 or 58% were small business firms.

Here is the list of 500, arranged in two sections. The first section includes the 397 business firms; the second section includes 103 government agencies and non-profit institutions:

SECTION I—397 BUSINESS FIRMS

Rank		Thousands of Dollars
1.	North American Aviation, Los Angeles	$567,744
2.	Lockheed, Burbank, Cal.	511,430
3.	General Electric, Schenectady, N. Y.	395,057
4.	General Dynamics, New York	313,061
5.	Martin Company. Baltimore	284,039
6.	Western Electric, New York	226,037
7.	Sperry Rand, New York	208,951
8.	Douglas, Santa Monica, Cal.	208,266
9.	Aerojet General, Cincinnati	161,955
10.	Boeing, Seattle	155,781
11.	Westinghouse, Pittsburgh	120,916
12.	General Motors, Detroit	85,828
13.	United Aircraft, East Hartford, Conn.	78,651
14.	Thiokol Chemical, Trenton, N. J.	73,871
15.	Pan American Airways, New York	71,380
16.	Raytheon, Waltham, Mass.	62,180
17.	Space Technology Labs., Los Angeles	61,030
18.	Avco Corp., New York	54,266
19.	American Bosch Arma, Hempstead, N. Y.	54,230
20.	Hughes Aircraft, Culver City, Cal.	49,480
21.	IBM, New York	47,809
22.	Bendix Aviation Corp., Detroit	47,410
23.	IT&T, New York	42,563
24.	Radio Corp. of America, Camden, N. J.	40,589
25.	Burroughs, Detroit	37,795
26.	McDonnell, St. Louis	32,441
27.	Republic, Farmingdale, N. Y.	27,962
28.	Sylvania, New York	27,401
29.	Collins Radio, Cedar Rapids, Iowa	24,929
30.	Goodyear Aircraft, Akron, Ohio	24,919
31.	Northrop, Beverly Hills, Cal.	23,086
32.	Hercules Powder, Wilmington, Del.	21,184
33.	Minneapolis Honeywell, Minneapolis	19,285
34.	Airborne Instruments Lab., Mineola, N. Y.	18,725
35.	Amer. Machine & Foundry, New York	17,997
36.	Bell Aircraft, Buffalo	17,885
37.	Thompson Ramo Wooldridge, Los Angeles	17,403
38.	Fairchild, Hagerstown, Md.	17,047
39.	Callery Chemical, Callery, Pa.	14,943
40.	Temco, Dallas	14,541
41.	Olin Mathieson, New York	13,738
42.	Philco, Philadelphia	13,025
43.	Litton Industries, Beverly Hills, Cal.	12,251
44.	Hayes Aircraft, Birmingham, Ala.	11,333
45.	Sangamo Electric, Springfield, Ill.	10,740
46.	Aeronutronic Systems, Glendale, Cal.	10,004
47.	Vitro Corp., New York	9,835
48.	Sundstrand, Rockford, Ill.	9,712
49.	Hoffman Electronics, Los Angeles	9,486
50.	General Mills, Minneapolis	9,421
51.	Marquardt, Van Nuys, Cal.	9,389
52.	Continental Electronics, Dallas	8,861
53.	Motorola, Chicago	8,377
54.	Land Air, Chicago	8,323
55.	Curtiss Wright, Wood-Ridge, N. J.	8,261
56.	Hazletine, Little Neck, N. Y.	7,808
57.	Rheem Mfg., New York	7,569
58.	A C F Industries, New York	7,554
59.	Vertol Aircraft, Morton, Pa.	7,471
60.	Melpar, Falls Church, Va.	6,816
61.	Sanders Associates, Nashua, N. H.	6,642
62.	Grumman, Bethpage, N. Y.	6,469
63.	Hallicrafters, Chicago	6,138
64.	Air Products, Allentown, Pa.	6,056
65.	Northern Ordnance, Minneapolis	5,500
66.	Atlantic Research, Alexandria, Va.	5,079
67.	Ryan Aeronautical, San Diego, Cal.	5,044
68.	Interstate Electronics, Anaheim, Cal.	4,982
69.	Control, Minneapolis	4,965
70.	Magnavox, Fort Wayne, Ind.	4,944
71.	Librascope, Glendale, Cal.	4,930
72.	American Radiator, New York	4,746
73.	Chrysler, Detroit	4,733
74.	Acoustic Associates, Mineola, N. Y.	4,595
75.	Cook Electric, Chicago	4,380
76.	Astrodyne, McGregor, Tex.	4,316
77.	Stavid Engineering, Plainfield, N. J.	4,259
78.	Clevite, Cleveland	3,691
79.	Universal Match, St. Louis	3,585
80.	Bell Helicopter, Ft. Worth	3,535
81.	Radiation, Melbourne, Fla.	3,464
82.	Brown Engineering, Huntsville, Ala.	3,445
83.	Food Machinery, San Jose, Cal.	3,409
84.	Little A. D., Cambridge, Mass.	3,404
85.	Telecomputing Corp., Los Angeles	3,373
86.	Emerson Electric, St. Louis	3,344
87.	Fairchild Camera, Syosset, N. Y.	3,323
88.	Cubic Corp., San Diego, Cal.	3,301
89.	Solar Aircraft, San Diego, Cal.	3,223
90.	Beech, Wichita, Kan.	3,196
91.	Eastman Kodak, Rochester	3,188
92.	Texas Instruments, Dallas	3,052
93.	Rohm & Haas, Huntsville, Ala.	3,024
94.	Polytechnic Research, Brooklyn, N. Y.	2,982
95.	Garrett Corp., Los Angeles	2,964
96.	American Optical, Southbridge, Mass.	2,642
97.	Borg Warner, Chicago	2,575
98.	Harvey Aluminum, Torrance, Cal.	2,507
99.	Continental Aviation & Engineer, Detroit	2,494
100.	LeTourneau (R. G.), Longview, Tex.	2,426
101.	Loral Electronics, New York	2,400
102.	Edo Corp., College Point, N. Y.	2,299
103.	Daystrom, Elizabeth, N. J.	2,280
104.	Aircraft Armaments, Cockeysville, Md.	2,257
105.	Gilfillan Bros., Los Angeles	2,252
106.	Ford Motor Co., Dearborn, Mich.	2,213
107.	Varian Associates, Palo Alto, Cal.	2,208
108.	Reeves Instrument, New York	2,143
109.	Dumont Laboratories, Clifton, N. J.	2,136
110.	Belock Instrument, College Point, N. Y.	2,092
111.	Emerson Radio, Jersey City, N. J.	2,046
112.	Litton Maryland, College Park, Md.	2,043
113.	Combustion Engineering, Chattanooga, Tenn.	2,008
114.	Maxson (W. L.), New York	1,960
115.	Electro-Optical Systems, Pasadena, Cal.	1,934
116.	Union Carbide, New York	1,887
117.	Dow Chemical, Midland, Mich.	1,870
118.	All American Engineering, Wilmington, Del.	1,853
119.	Coleman Engineering, Los Angeles	1,848
120.	Lenkurt Electric, San Carlos, Cal.	1,838
121.	Elgin Watch, Elgin, Ill.	1,805
122.	Barnes Engineering, Stamford, Conn.	1,767
123.	Tracerlab, Boston	1,733
124.	Flightex Fabrics, Cambridge, Mass.	1,724
125.	Allied Research, Boston	1,634
126.	Air Logistics, Pasadena, Cal.	1,632
127.	Technical Appliance, Sherburne, N. Y.	1,627
128.	Ampex, Los Angeles	1,579
129.	U. S. Steel, Pittsburgh	1,515
130.	TRG, Inc., New York	1,483
131.	Minnesota Mining, Minneapolis	1,469
132.	Hiller Aircraft, Palo Alto, Cal.	1,465
133.	Ceir, Arlington, Va.	1,453
134.	Cleveland Pneumatic, Cleveland	1,382
135.	Bulova, Woodside, N. Y.	1,376
136.	Pacific Car & Foundry, Renton, Wash.	1,310
137.	Arinc Research, Washington, D. C.	1,258
138.	Esso Research & Engineering, Elizabeth, N. J.	1,254
139.	Piasecki, Philadelphia	1,213
140.	Flexonics, Maywood, Ill.	1,199
141.	Autometric, New York	1,189
142.	Aeronca Manufacturing, Middletown, Ohio	1,188
143.	Technical Operations, Burlington, Mass.	1,169
144.	Hughes Tool, Culver City, Cal.	1,139
145.	Perkin Elmer, Norwalk, Conn.	1,130
146.	Telephonics, Huntington, L. I., N. Y.	1,115
147.	AFN Inc., Los Angeles	1,113
148.	Polarad Electronics, Long Island City, N. Y.	1,080
149.	Santa Barbara Research, Goleta, Cal.	1,077
150.	Ferrand Optical, New York	1,077

Rank		Thousands of Dollars
151.	Times Facsimile, New York	1,046
152.	Technitrol Engineering, Philadelphia	1,046
153.	Kearfott Co., Clifton, N. J.	1,044
154.	National Company, Malden, Mass.	1,040
155.	Goodrich (B. F.), Akron, Ohio	1,033
156.	Computer Control, Babson Park, Mass.	1,014
157.	Electronic Communications, Teterboro, N. J.	1,013
158.	Underwood Corp., New York	1,000
159.	Monsanto Chemical, St. Louis, Mo.	992
160.	American Electronic Lab., Philadelphia	987
161.	Edgerton Germeshausen & Grier, Boston	983
162.	Radiation Engineering Labs., Maynard, Mass.	968
163.	Bliss (E. W.), Canton, Ohio	964
164.	Eitel McCullough, San Bruno, Cal.	955
165.	Barnes and Reinecke, Chicago	949
166.	Developmental Engineering, Washington, D. C.	942
167.	Standard Oil (Indiana), Chicago	924
168.	Bolt, Beranek & Newman, Cambridge, Mass.	918
169.	HRB Singer, State College, Pa.	906
170.	Link Aviation, Palo Alto, Cal.	897
171.	Carrier Corp., Syracuse	893
172.	Textron, Belmont, Cal.	889
173.	Aerolab Development, Pasadena, Cal.	855
174.	Booz Allen Applied Research, Kenilworth, Ill.	843
175.	National Cash Register, Dayton, Ohio	833
176.	Firestone, Akron, Ohio	812
177.	Norman Engineering, Beverly Hills, Cal.	810
178.	McKiernan Terry, Dover, N. J.	802
179.	Stearns-Rogers Mfg., Denver	799
180.	Pickard-Burns, Needham, Mass.	792
181.	General Electronics Laboratories, Cambridge, Mass.	791
182.	Whirlpool, St. Joseph, Mich.	789
183.	Dynatronics, Orlando, Fla.	781
184.	Plasmadyne, Santa Ana, Cal.	771
185.	Kaman Aircraft, Bloomfield, Conn.	768
186.	Hamilton Watch, Lancaster, Pa.	768
187.	Reynolds Metals, Richmond	766
188.	Experiment, Inc., Richmond	765
189.	Allied Chemical, New York	761
190.	Wyandotte Chemical, Wyandotte, Mich.	755
191.	Dunlap & Associates, Stamford, Conn.	751
192.	White Motor Co., Detroit	739
193.	Laboratory for Electronics, Boston	732
194.	Geotechnical, Dallas	726
195.	American Cynamid, New York	720
196.	Watkins Johnson, Palo Alto, Cal.	715
197.	Consolidated Electrodynamics, Pasadena, Cal.	713
198.	Federal Electric, Paramus, N. J.	710
199.	Chamberlain, Waterloo, Iowa	707
200.	Microwave Associates, Burlington, Mass.	694
201.	Beechcraft Research, Wichita, Kan.	690
202.	Planning Research, Los Angeles	688
203.	Lear, Santa Monica, Cal.	686
204.	Applied Science, Princeton, N. J.	685
205.	Instruments for Industry, Mineola, N. Y.	684
206.	Gruen Applied Science Lab., Hempstead, N. Y.	681
207.	EPSCO, Inc., Boston	679
208.	Eastern Precision Resistor, Brooklyn, N. Y.	676
209.	Continental Motors, Muskegon, Mich.	673
210.	Design Service, New York	673
211.	Control Instrument, Brooklyn, N. Y.	665
212.	Admiral Corp., Chicago	654
213.	Stauffer Chemical, Azusa, Cal.	649
214.	C.G.S. Labs, Ridgefield, Conn.	649
215.	United Electrodynamics, Pasadena, Cal.	644
216.	Doak Aircraft, Torrance, Cal.	640
217.	Telemeter Magnetics, Los Angeles	635
218.	Cooper Development, Monrovia, Cal.	633
219.	American Marietta, Wheeling, Ill.	630
220.	Clark (David) Co., Worcester, Mass.	630
221.	Alco Products, Schnectady, N. Y.	626
222.	Kennedy (D. S.), Cohasset, Mass.	618
223.	Bermite Powder, N. Hollywood, Cal.	617
224.	Pennsalt Chemical, Philadelphia	615
225.	Robertshaw Fulton, Greensburg, Pa.	614
226.	Galloway (G. W.), Arcadia, Cal.	612
227.	Sanders and Thomas, Pottstown, Pa.	604
228.	Seeburg, Chicago	593
229.	Baird Atomic, Cambridge, Mass.	577
230.	Thompson (John I.), Washington, D. C.	573
231.	Smyth Research, San Diego, Cal.	570
232.	Struthers Wells, Warren, Pa.	570
233.	Webcor, Chicago	569
234.	Packard Bell, Los Angeles	564
235.	Electronic Associates, Long Branch, N. J.	560
236.	Consultants and Designers, Arlington, Va.	557
237.	Operations Research, Silver Spring, Md.	547
238.	Comstock & Wescott, Cambridge, Mass.	542
239.	DuPont (E. I.) de Nemours, Wilmington, Del.	540
240.	Gyrodyne, New York	505
241.	Dewey (G. C.), New York	500
242.	Ethyl Corp., Detroit	499
243.	Manson Laboratories, Stamford, Conn.	498
244.	Servo Corp. of America, New Hyde Park, N. Y.	494
245.	Aero Service, Philadelphia	491
246.	Alloyd Research, Watertown, Mass.	487
247.	Shell Development, Emeryville, Cal.	486
248.	Magnesium Products, Milwaukee	477
249.	Crucible Steel, Pittsburgh	473
250.	United Geophysical, Pasadena, Cal.	472
251.	Gulton Industries, Metuchen, N. J.	472
252.	Washington Technological, Rockville, Md.	467
253.	Universal-Cyclops Steel, Bridgeville, Pa.	467
254.	Electro-Mechanical Research, Sarasota, Fla.	465
255.	National Research, Boston	464
256.	U. S. Rubber, New York	460
257.	Budd Co., Philadelphia	458
258.	Benson Lehner, Los Angeles	457
259.	Progressive Welders, Pontiac, Mich.	452
260.	Fenske, Fedrick & Miller, Los Angeles	451
261.	Jamesbury, Worcester, Mass.	448
262.	Jansky & Bailey, Washington, D. C.	448
263.	Bridgeport Brass, Riverside, Cal.	436
264.	Titanium Metals, New York	436
265.	Turbo Machine, Lansdale, Pa.	436
266.	Hycon Manufacturing, Pasadena, Cal.	425
267.	Narmco Industries, San Diego, Cal.	422
268.	N. T. W. Corp., Los Angeles	420
269.	Tele-Dynamics, Philadelphia	413
270.	Hermes Electronics, Cambridge, Mass.	408
271.	Stewart Warner, Chicago	402
272.	Kaiser Industries, Oakland, Cal.	395
273.	Microwave Engineering Labs, Palo Alto, Cal.	395
274.	General Precision Lab., Pleasantville, N. Y.	391
275.	American Potash & Chemical, Los Angeles	389
276.	Consolidated Welding Engineering, Chicago	388
277.	Eagle Picher, Cincinnati	388
278.	General Applied Science Labs., Hempstead, N. Y.	380
279.	Caterpillar Tractor, Peoria, Ill.	376
280.	Sanborn Co., Waltham, Mass.	374
281.	Maico Co. (The), Minneapolis	364
282.	Western Gear Works, Lynwood, Cal.	363
283.	Willys Motors, Toledo	363
284.	International Latex, Dover, Del.	361
285.	Kellogg (M. W.) Co., Jersey City, N. J.	358
286.	Power Generators, Trenton, N. J.	358
287.	Otis Elevator, Cleveland	352
288.	Haloid Xerox, Rochester, N. Y.	351
289.	American M A R C, Inglewood, Cal.	350
290.	Arnonx Corp., Los Angeles	347
291.	MSA Research Corp., Callery, Pa.	347
292.	Ladish Co., Cudahy, Wisc.	346
293.	Jered Industries, Hazel Park, Mich.	345
294.	United Research, Cambridge, Mass.	344
295.	Research, Inc., Hopkins, Minn.	339
296.	Mallory Sharon Titanium, Niles, Ohio	335
297.	Darco Industries, El Segundo, Cal.	331
298.	Noble Co., Oakland, Cal.	330
299.	National Northern, West Hanover, Mass.	330
300.	Steinthal (M.) Co., New York	325
301.	Consolidated Diesel Electric, Stamford, Conn.	324
302.	Maxim Silencer Co., Hartford, Conn.	324
303.	Houston Fearless Corp., Los Angeles	321
304.	Ordnance Engineering Asso., Chicago	315
305.	Nuclear Development, White Plains, N. Y.	312
306.	Ingersoll Rand Co., Phillipsburg, N. J.	311
307.	Aerochemical Research Lab., Princeton, N. J.	309
308.	International Aerocoustics, New York	309
309.	Filtron Co., Flushing, N. Y.	307
310.	Consolidated Avionics, Westbury, N. Y.	306
311.	Ball Brothers Research, Boulder, Colo.	305
312.	Block Associates, Cambridge, Mass.	305
313.	West Coast Electronics, Beverly Hills, Cal.	305
314.	Colorado Research, Denver	304
315.	Isotopes, Inc., Westwood, N. J.	299
316.	Ewen Knight Corp., Needham, Mass.	299
317.	Huyck (F. C.) Sons, Huntington Station, N. Y.	295
318.	Aeroprojects, Westchester, Pa.	291
319.	Winzen Research, Minneapolis	288
320.	Kollsman Instrument, Elmhurst, N. Y.	287
321.	Harshaw Chemical Co., Cleveland	286
322.	Dresser Industries, Dallas, Tex.	282
323.	Permanent Filter Corp., Los Angeles	281
324.	Page Communications Engineers, Washington, D. C.	279
325.	Bausch & Lomb Optical, Rochester, N. Y.	275
326.	Ling Altec Electronics, Culver City, Cal.	274
327.	M & T Co., Philadelphia	271
328.	Mallory (P. R.) Co., Indianapolis, Ind.	270
329.	AR&T Electronics, Little Rock, Ark.	269
330.	Mine Safety Appliances, Pittsburgh	269
331.	Miller Metal Products, Baltimore	267
332.	Grand Central Rocket, Redlands, Cal.	265
333.	Bjorksten Research Labs., Madison, Wisc.	265
334.	Spaco Manufacturing Co., Huntsville, Ala.	262
335.	Townsend Engineered Products, Santa Ana, Cal.	261
336.	General Atronics Corp., Bala-Cynwyd, Pa.	260
337.	Reed Research, Washington, D. C.	260
338.	Brubaker Electronics, Culver City, Cal.	256
339.	Apex Machine Tool, Philadelphia	256
340.	CTL, Inc., Cincinnati	256
341.	Psychological Research Asso., Arlington, Va.	255
342.	Fairbanks Morse Co., Chicago	254
343.	Universal Winding Co., Providence	252
344.	Dynamics Research, Los Angeles	251
345.	Texas Nuclear Corp., Austin, Tex.	249
346.	Teague (Walter Dorwin), New York	249
347.	Breeze Corp., Inc., Union, N. J.	249
348.	Owens Corning Fiberglas, Toledo, Ohio	248
349.	Central Electronic Mfg., Denville, N. J.	248
350.	Tung Sol Electric, Newark	239
351.	North Electric Co., Galion, Ohio	238
352.	Goodyear Tire & Rubber, Akron, Ohio	237
353.	Campbell Contour Attachment, Long Beach, Cal.	237
354.	Feedback Controls, Waltham, Mass.	237
355.	Plesset (E. H.) Associates, Los Angeles	237
356.	Raymond Engineering Labs., Middletown, Conn.	236
357.	Carborundum Co., Niagara Falls, N. Y.	236
358.	Engelhard Industries, Newark, N. J.	236
359.	Stevens (L. E.) Co., Newport, Ky.	235
360.	National Scientific Labs., Washington, D. C.	232
361.	Worthington Corp., Harrison, N. J.	232
362.	Standard Mfg. Corp., Dallas	231
363.	Brush Beryllium Co., Cleveland, Ohio	231
364.	U. S. Testing Co., Hoboken, N. J.	231
365.	Fenwal Inc., Ashland, Mass.	229
366.	Gladding McBea Co., Los Angeles	228
367.	Canoga Corp. of California, Van Nuys, Cal.	227
368.	Zenith Radio, Chicago	227
369.	Oster (John) Mfg. Co., Racine, Wisc.	226
370.	Ashland Oil Refining Co., Ashland, Ky.	225
371.	Eureka Williams Corp., Bloomington, Ill.	224
372.	Aero Geo Astro Corp., Alexandria, Va.	223
373.	Royal Industries, Inc., Alhambra, Cal.	222
374.	United Shoe Machinery, Beverly, Mass.	222
375.	Scope, Inc., Fairfax, Va.	221
376.	Tenney Engineering, Union, N. J.	221
377.	Chesapeake Instrument Corp., Shadyside, Md.	218
378.	Berger Bros. Co., New Haven, Conn.	217
379.	Lionel Corp., Irvington, N. J.	216
380.	Nuclear Corp. of America, Burbank, Cal.	216
381.	Teletype Corp., Chicago	215
382.	Scandia Manufacturing Co., Baltimore	215

Rank	Thousands of Dollars
383. Stoddart Aircraft Radio, Hollywood, Cal.	214
384. Giannini (G. M.) Co., Pasadena, Cal.	213
385. Research Chemicals, Inc., Burbank, Cal.	212
386. Manufacturing Labs., Inc., Cambridge, Mass.	210
387. Documentation, Inc., Washington, D. C.	209
388. Schjeldahl (G. T.) Co., Northfield, Minn.	208
389. Packard Bell Computer, Los Angeles	208
390. New York Air Brake Co., Boston	207
391. Geophysics Corp., Boston	207
392. Stelma, Inc., Stamford, Conn.	206
393. Bomac Laboratories, Beverly, Mass.	205
394. Professional Design, Agawam, Mass.	204
395. Nordberg Mfg. Co., Milwaukee	203
396. Chu Associates, Littleton, Mass.	203
397. Hoover Electronics Co., Timonium, Md.	202

SECTION II—103 GOVERNMENT AGENCIES AND NON-PROFIT INSTITUTIONS

Rank	Thousands of Dollars
1. Massachusetts Institute of Technology, Cambridge	$88,659
2. California Institute of Technology, Pasadena	31,651
3. Johns Hopkins University, Baltimore	31,097
4. Rand Corp., Santa Monica, Cal.	13,236
5. Michigan, University of, Ann Arbor	11,690
6. Columbia University, New York	11,263
7. Stanford Research Institute, Menlo Park, Cal.	11,082
8. Cornell Aeronautical Lab., Inc., Buffalo	8,783
9. California, University of, Berkeley, Cal.	8,183
10. Leland Stanford University, Stanford, Cal.	7,744
11. Armour Research Foundation, Chicago	6,951
12. Illinois, University of, Urbana	5,202
13. New York University, New York	4,879
14. Princeton University, Princeton, N. J.	4,746
15. Chicago, University of, Chicago	4,364
16. Battelle Memorial Institute, Columbus, Ohio	4,032
17. Texas, University of, Austin, Tex.	4,007
18. Harvard University, Cambridge, Mass.	3,570
19. U. S. Department of Commerce, Washington, D. C.	3,484
20. George Washington University, Washington, D. C.	3,071
21. Penn State University, University Park	2,916
22. Minnesota, University of, Minneapolis	2,902
23. Washington, University of, Seattle	2,704
24. Ohio State University, Columbus	2,641
25. Woods Hole Oceanographic Lab., Woods Hole, Mass.	2,584
26. Cornell University, Ithaca, N. Y.	2,570
27. Dayton, University of, Dayton, Ohio	2,353
28. New Mexico College of Agric. & Mech. Arts, State College	2,092
29. National Academy of Sciences, Washington, D. C.	1,984
30. Duke University, Durham, N. C.	1,923
31. Franklin Institute, Philadelphia	1,900
32. Institute for Defense Analysis, Washington, D. C.	1,900
33. Maryland, University of, College Park	1,874
34. Southwest Research Institute, San Antonio, Tex.	1,718
35. Pennsylvania, University of, Philadelphia	1,630
36. Georgia Technical Research Institute, Atlanta	1,394
37. Brown University, Providence	1,345
38. Midwest Research Institute, Kansas City, Mo.	1,323
39. Pittsburgh, University of, Pittsburgh	1,317
40. Washington University, St. Louis	1,287
41. Illinois Institute of Technology, Chicago	1,268
42. Wisconsin, University of, Madison	1,147
43. Denver University, Denver	1,100
44. Colorado, University of, Boulder	1,067
45. Northwestern University, Evanston, Ill.	1,057
46. Carnegie Institute of Technology, Pittsburgh	1,049
47. U. S. Treasury Department, Washington, D. C.	1,015
48. Syracuse University, Syracuse, N. Y.	1,011
49. Polytechnic Institute of Brooklyn, Brooklyn, N. Y.	976
50. Analytic Services, Inc., Santa Monica, Cal.	968
51. Utah, University of, Salt Lake City	958
52. Yale University, New Haven, Conn.	952
53. American University, Washington, D. C.	908
54. Stevens Institute of Technology, Hoboken, N. J.	878
55. Mellon Institute, Pittsburgh	837
56. Alaska, University of, College	815
57. Case Institute of Technology, Cleveland	782
58. Texas A & M College, College Station	767
59. Wentworth Institute, Boston, Mass.	749
60. Smithsonian Institution, Washington, D. C.	711
61. Miami University, Coral Gables, Fla.	628
62. Rochester University, Rochester, N. Y.	621
63. U. S. Atomic Energy Commission, Washington, D. C.	604
64. Western Reserve University, Cleveland	596
65. Catholic University of America, Washington, D. C.	586
66. Southern California, University of, Los Angeles	585
67. Virginia, University of, Charlottesville	567
68. Arizona, University of, Tucson	540
69. Purdue Research Foundation, Lafayette, Ind.	514
70. Florida State University, Tallahassee	481
71. Tufts College, Medford, Mass.	472
72. American Institute of Research, Pittsburgh	465
73. Rensselaer Polytechnic Institute, Troy, N. Y.	458
74. Vanderbilt University, Nashville, Tenn.	463
75. North Carolina, University of, Chapel Hill	445
76. Massachusetts General Hospital, Boston	441
77. Oklahoma A & M College, Stillwater	429
78. Notre Dame University, South Bend, Ind.	429
79. Florida, University of, Gainesville	417
80. Southern Research Institute, Birmingham, Ala.	406
81. Northeastern University, Boston	394
82. Georgia Institute of Technology, Atlanta	370
83. Indiana, University of, Bloomington	354
84. Rutgers University, New Brunswick, N. J.	345
85. Iowa, University of, Iowa City	342
86. New Mexico, University of, Albuquerque	342
87. Cincinnati, University of, Cincinnati	328
88. Temple University, Philadelphia	324
89. Tennessee, University of, Knoxville	292
90. Lowell Technical Institute, Lowell, Mass.	284
91. Buffalo, University of, Buffalo	274
92. Oklahoma, University of, Norman	271
93. Mississippi State College, State College	266
94. North Carolina State College, Raleigh	261
95. Boston College, Chestnut Hill, Mass.	257
96. Baylor University, Houston	254
97. Oregon State College, Corvallis	235
98. Louisiana State University, Baton Rouge	231
99. Wichita, University of, Wichita, Kan.	229
100. Georgetown University, Washington, D. C.	229
101. Iowa State College, Ames	222
102. Michigan State College, East Lansing	217
103. New Hampshire, University of, Durham	209

Recent contract awards:

NAVY

$49,900—**Cleveland Consolidated, Mechanical Div of Cleveland Electric Co.**, Jacksonville, Fla., for dehumidification of magazines at the *Polaris* missile assembly, Charleston, S.C.

$43,488—**J. Young Construction Co.**, Beaufort, S.C., for construction of liquid oxygen storage and transfer facility.

$40,700—**Garland O. Banta**, Tustin, Calif., for construction of liquid oxygen transfer facilities, El Toro, Calif.

NASA

$124,000—**ACF Electronics Division of ACF Industries, Inc.**, Riverdale, Md., for production of radar beacons for use in Project *Delta*.

AIR FORCE

Minneapolis-Honeywell Regulator Co., has received a multimillion-dollar contract for building a simulator for space vehicle and advanced aircraft testing.

Pacific Automation Products, Inc., Glendale, Calif., for emplacement of ground support electronics equipment at three *Atlas* launch control centers. Subcontract from **RCA**. Amount not disclosed.

Gladding, McBean & Co., Los Angeles, for research and development of a refractory material for use in uncooled rocket flame deflectors. Subcontract from Marquardt Corp. Amount not disclosed.

Bendix Aviation Corp., for developing, building and testing a "hot gas" flight stabilization and control system for "semi-orbital aerospace vehicles and missiles." Amount not disclosed.

$1,000,000—**Kieley & Mueller, Inc.**, Middletown, N.Y., for production of all of the automatic flow-control valves for operational propellant-loading systems at four *Titan* bases. Subcontract from **CompuDyne Corp.**

$606,750—**Thiokol Chemical Corp.**, Elkton, Md., for research into large rocket engine propellants.

$71,192—**Control Equipment Corp.**, Needham Heights, Mass., for design and development of instrumentation for study of density pressure temperature and composition of upper atmosphere.

$45,922—**Grand Central Rocket Co.**, Redlands, Calif., for rocket motors for high-speed test track.

$39,947—**New Mexico College of Agriculture and Mechanical Arts**, for research and development of antennas for rocket trajectory and data transmission equipment and associated ground stations.

ARMY

Control Electronics Co., Inc., Huntington Station, N.Y., for 100 microwave duplexers. Amount not disclosed.

$463,694—**Douglas Aircraft Co.**, Santa Monica, Calif., for improved *Honest John* rockets without warhead.

$274,960—**Raytheon Co.**, Andover, Mass., for repair parts and replenishment repair parts for the *Hawk* system. (Two contracts.)

$234,641—**Western Electric Co., Inc.**, New York City, for *Nike* spare parts and components. (Two contracts.)

$169,280—**Gatewood Construction Co.**, Dallas, for construction of missile maintenance training shop.

$128,981—**Douglas Aircraft Co., Inc.**, Santa Monica, for shipping containers for guidance section of *Nike-Hercules* missiles.

$84,800—**Pirie J. Maloney Construction Co.**, Rumson, N.J., for construction of the maintenance shop with related site improvements and outside utilities for *Bomarc* at McGuire AFB.

$69,785—**Barnes Engineering Co.**, Stamford, Conn., for field measurements of reentry of missiles.

$56,424—**Crosley Div., Avco Corp.**, Cincinnati, for satellite decoders, drawings and specifications.

$56,357—**Sperry Rand Corp.**, Salt Lake City, for *Sergeant* missiles.

$46,473—**Douglas Aircraft Co.**, Santa Monica, for repair parts for *Nike* systems.

$46,318—**Harland Bartholomew & Associates**, Honolulu, for architect-engineering services for redesign of *Nike-Hercules* Battery Site 1, Oahu.

$28,082—**Waste King Corp.**, Los Angeles, for warhead fuze.

Misconceptions

To the Editor:

We read MISSILES AND ROCKETS with nterest and find the information to be imely and significant. Grand Central vas pleased, therefore, to note the mention of its activity in high energy and nulti-million pound boost motors in the February 8 issue.

Recognizing the massive editorial problems in obtaining accurate information about programs and policies, it is with regret we find it necessary to point out some misconceptions possible to the eaders of the story.

1. Grand Central Rocket Co. has been associated with Marquardt in joint work on a hybrid propellant system. We feel that the Marquardt-Grand Central Rocket hybrid system is one of considerable promise. We have not, however, proposed a hybrid system for the "multi-million-pound solid space booster." Marquardt and Grand Central did not propose as a "team" on this job.

2. Grand Central has made excellent progress on adaptation and further development of the Nitrasol propellant originally conceived at NOTS and has been able to demonstrate an exceptionally good I_{sp}. We do not, however, consider Nitrasol to have performance comparable to the "blue sky" propellants which Advanced Research Projects Agency is investigating within the 285 I_{sp} range. We are working with other materials that have good promise of the higher performance but are not prepared to discuss them until we have completed our studies and tests.

3. The article mentions Air Force plans, policies and intent. Interleaved between are comments regarding Grand Central Rocket Co. activities, as well as the activities of other companies. The inference could be drawn that Grand Central Rocket Co. is commenting upon the policy and practice of the Air Force and of our competitors. This inference would be incorrect. Grand Central does not engage in the practice of disseminating public information or comments on Air Force policy or on the thinking of our competitors.

Cledo Brunetti
Vice President
and General Manager
Grand Central Rocket Co.

Future Lies Ahead

To the Editor:

1960 SPACE RACE PROGRAM

January—*Titan* Falls in Swimming Pool at Fontainebleau Hotel.

February—Gates Hails Merger of Air Force and NASA as Boon to Missile Program.

March—Project *Saturn* Budget Upped to \$3,467.75.

April—"Massive Inferiority" Doctrine Enunciated by President.

May—Administration Calls SAC Manned Bombers Best Deterrent to Soviet Space Stations.

June—Eisenhower Refuses to Let Soviets Use Great Salt Lake as Rangehead for 15,000-mile Missile.

July—*Saturn* Budget Doubled.

August—Ike says U.S. Mothball Fleet More Than Match for Soviet Missiles.

September—NASA and Air Force Separated to Speed Space Program—Gates says: "Organizationally, we've got them cowering."

October—*Titan* Falls on Fidel Castro—Increased Range Hailed.

November—Soviet Missile Base on Moon Termed "Gimmick" by Nixon.

December—Contract Let for Development of Longbow.

Charles V. Hopkins
925 Loring Street
San Diego 9, Calif.

Textbook Lack

To the Editor:

An interesting subject, that letter from Bombay (M/R, Jan. 25) about the need for textbooks. It reminds me of a talk I had recently with one of Holland's pioneers in astronautics, M. Vertregt. He complained that he could not afford American advanced textbooks. He also deplored the fact that even the Netherlands Astronautical Association could not afford to add them to its technical library.

It is, of course that awful dollar barrier (or should I say dollar curtain) that is to blame.

J. A. Redeker
Science Editor
Algemeen Dagblad
Rotterdam, Netherlands

Close, But No Cigar

To the Editor:

Look at the caption at the top of pages 56/57 in the July 20 M/R:

"Series of photographs of dog-carrying *Sputnik II* made it possible *to deduct* that the total length of rocket body," etc.

"TO DEDUCT"—Really! Gentlemen, you're making us feel ill. Whoever penned that little gem ought to be "destructed."

L. S. Eggleton
Montreal Chapter
Society of Technical Writers
and Editors

Webster lists "deduct . . . To draw as a conclusion as from reasoning." (Same Latin root, same meaning as "deduce.")—Ed.

in historic speech . . .

Power Sees 'Aerospace Missile Force'

Manned air/spacecraft would serve as launch platforms; SAC chief says 300 accurate ICBM's could knock out U.S. bomber and missile sites in 30 minutes unless they're hardened

These are the Pertinent Power Points

The U.S. has about 100 sites from which nuclear-armed aircraft or missiles can be launched.

It would take an average of three each—or a total of only 300—Soviet ballistic 5000-mile ballistic missiles to wipe out these 100 sites in 30 minutes.

If the sites are hardened it would take "considerably more."

Khrushchev says that Russia is now in "serial production" of nuclear missiles at the rate of 250 a year. Some must be presumed to be nuclear.

U.S. deterrent strength must be measured in what we would have *after* an attack—not before it.

SAC considers the manned bomber and the ballistic missile as complementary weapon systems.

Advent of the long-range air-to-ground missile (*Hound Dog*) greatly enhances power and versatility of manned bomber.

The combination of the B-52 and the *Hound Dog* is only first step in marriage of manned bomber and missile.

Further—SAC is planning an "aerospace" force of manned bombers and missiles.

We are near a nuclear stalemate with Russia—but there is no real stalemate as long as the Soviets can tip the scales merely by taking the initiative.

General Thomas S. Power is commander in chief of the Strategic Air Command, responsible for maintaining the terrible retaliatory power which the West depends on to deter Soviet aggression. His New York speech on Jan. 19, urgently warning of Russia's missile striking ability, has intensified the debate over how big the Missile Gap really is. The President himself took occasion to criticize "parochial" generals who disagree with the Administration estimate. Because M/R believes that Power's military and geopolitical philosophy (and his analysis of our forces-à-vis the USSR) is vitally important, we are carrying his speech here virtually in its entirety.—Editor.

* * *

The American people today are faced with the most difficult and far-reaching decisions in the history of this nation. Through their elected representatives they must decide what course to follow in their quest for peace and what tools to furnish to insure the successful pursuit of that course.

Similar decisions had to be made after World War II when the United States emerged as the most powerful nation on earth and was thrust into the role of guardian of the newly won peace. It was then that we evolved a policy unprecedented in the history of this country, namely, the policy of deterring aggression through the threat of massive retaliation. To support this policy, we created a military tool, equally unprecedented as to character and scope—the Strategic Air Command. This combination of political strength and military superiority undoubtedly was the major factor in preventing another world war to this date.

But Soviet Russia, which ten years ago seemed as unlikely a challenger to our leadership as Communist China may seem today, almost overnight developed into a major threat, not only to our overall supremacy but to our very survival. For the Soviets had achieved the capability to undertake what neither Lenin nor Stalin ever dreamed would be possible—a devastating attack on the United States.

• **Three questions**—It is . . . well to ask . . . three pertinent questions. First, is our national policy of deterrence still feasible and desirable? Second, if we decide that it is, can our present and projected military posture support that policy adequately? And, third, with continued advances in military technology, will we eventually reach a point where a policy of deterrence is no longer possible?

It is vital to the future security of this country that we find conclusive answers to these questions even though the many variables and unpredictable factors involved leave considerable room for speculation and individual preferences. This applies, in particular, to the problem of determining the most promising approach for preventing aggression.

We can start out from the premise that everyone is agreed on the urgent need of preserving the peace. But this is where the agreement ends, because people have widely differing ideas as to the kind of peace they would accept and the price they are prepared to pay for it. Some people may be willing to buy peace, however meaningless, at any price, even at the expense of their human rights and freedom. I take a different position from their defeatist attitude; I maintain that death is preferable to life under Communism. Obviously, we both cannot be right; however, I am confident that the vast majority of our citizens shares my convictions.

As President Eisenhower said in his State of the Union Message early this month: "Still another avenue may be found in the field of disarmament, in which the Soviets have professed a readiness to negotiate seriously. They have not, however, made clear the plans they may have, if any, for mutual inspection and verification—the essential condition for any extensive measure of disarmament."

In this connection, let me also

quote a rather significant statement made at the Lenin School of Political Warfare in 1931—almost 30 years ago —by Dimitry Z. Manuilsky, who was a prominent member of the powerful Central Committee of the Communist Party and later head of the Ukrainian delegation to the United Nations. Here is what Comrade Manuilsky said, as reported by a former student at that school:

"War to the hilt between communism and capitalism is inevitable. Today, of course (that is, in 1931), we are not strong enough to attack. Our time will come in 20 or 30 years. To win, we shall need the element of surprise. The bourgeoisie will have to be put to sleep. So we shall begin by launching the most spectacular peace movement on record. There will be electrifying overtures and unheard-of concessions. The capitalist countries, stupid and decadent, will rejoice to cooperate in their own destruction. They will leap at another chance to be friends. As soon as their guard is down, we shall smash them with our clenched fist." We cannot ignore the fact that utterances of this kind have been made by the Soviets over the past four decades.

• **The best way**—Finally, we can endeavor to maintain an honorable peace through an overpowering posture of balanced military strength and . . . collective security arrangements, as we have done since the end of World War II. I do not claim that, in this or in any other manner, we can stay out of a war. But I am convinced that this is the most promising and, in the long run, least expensive way of averting nuclear war.

It is claimed that our policy of deterrence cannot cope with the growing threat of small wars so long as we devote most of our efforts and resources to the deterrence of total nuclear war. But, in my considered opinion, the principle of deterrence through military superiority is broad and flexible enough to permit its application to any kind of conflict, regardless of its place, scope and nature.

Our overall deterrent posture is a composite of a number of elements which go to make up military superiority. These include our own forces as well as those of our allies with whom we have collective security arrangements. A fundamental element of that deterrent posture is our strategic retaliatory strike force.

That strike force is not the only factor which deters aggression, but without a fully effective retaliatory force capable of inflicting on an aggressor damage which he considers unacceptable, there is no meaningful deterrent. At this time, SAC, which is

GEN. POWER earlier wrote a book, "Design for Survival," charging defense spending was inadequate. DOD banned it.

by far the principal element of the Free World's strategic retaliatory capability, receives less than 20% of the U.S. defense dollar and still smaller fractions of other resources.

Since military superiority is accepted as the prerequisite for a successful policy of deterrence, the question arises whether and for how long we can maintain an adequate margin of overall superiority. I am confident that, as of the moment, this margin is still large enough to deter the Soviets from risking war with the United States, despite their spectacular technological advances.

• **No Red SAC**—Indications are that, if the Soviets decided to launch a surprise attack . . . today, they would have to rely mainly on their long-range bomber force. Evidently, this force has neither the size and quality nor the global support facilities and centralized organization which give SAC's forces their unmatched strike capability. Moreover, this country has an extensive air defense system against manned bombers which would provide sufficient warning of their approach to permit the launching of SAC's alert force before it could be attacked on the ground.

The Soviets are well aware of the fact that a sizeable percentage of SAC's strike force is on an around-the-clock 15-minute alert and that even their most advanced defenses could not prevent that force from inflicting crippling damage on their military controls and installations.

Nevertheless, we can certainly expect that the Soviet leadership would take full political advantage of any military superiority over the Free World which it may be able to obtain in the future. If they could effectively threaten us from a position of such military superiority that we would feel unable to defend ourselves successfully against the weapons they command, our capability to resist Soviet advances by means of subversion and political blackmail would be greatly reduced, if not nullified.

Military superiority of this magnitude would be achieved through the accumulation of a sufficient stockpile of ballistic missiles to destroy our retaliatory forces before they could be launched. Surprisingly enough, this would not take very many missiles under present conditions. Published statistics show that the total number of installations and facilities from which we can launch nuclear-armed aircraft or missiles at this moment is only about one hundred. All of these facilities present "soft targets," that is, they could suffer crippling damage even in the event of a near-miss.

According to released data on nuclear effects, it would take an average of three missiles, in their current state of development, to give an aggressor a mathematical probability of 95% that he can destroy one given soft target, some 5000 miles away. This means that, *with only some 300 ballistic missiles, the Soviets could virtually wipe out our entire nuclear strike capability within a span of 30 minutes.* To further heighten this threat, only about half of these missiles would have to be ICBM's. The rest could be the smaller IRBM's which are considerably less expensive and easier to produce.

Because of their tremendous speed, averaging about 15,000 miles an hour, ballistic missiles offer unique advantages to an aggressor who plans a surprise attack. It stands to reason that this has spurred the Soviets' effort to augment whatever quantities they may already possess at the greatest possible rate. Khrushchev himself let it be known that Russia is now engaged in the "serial production" of these missiles and that one single factory is turning out some 250 missiles a year, presumably including ballistic missiles.

• **Until BMEWS**—Therefore, we must anticipate that the Soviets may have . . . a sufficient number of operational ICBM's and IRBM's for an all-out missile attack before we have in operation warning systems which could provide reliable and adequate warning of such an attack. We have such systems now under development, designed to give some 15 minutes warning, which would suffice to get most or all of SAC's ground-alert forces airborne. But until our Ballistic Missile Early Warning System becomes fully operational, SAC's capability to survive a missile attack with little or no warning will be the crux of the Free World's deterrent posture.

Hound Dog is a first step . . .

There is increasing public awareness of the mounting problem of survivability of our strike capability in a nuclear surprise attack. It must be understood that our deterrent strength is not determined by the forces which we have in being *before* such an attack but only by those forces which we can be certain to have left *after* the attack. From a deterrent point of view, therefore, the decisive factor is whether we can keep the Soviets convinced that, even under the most unfavorable conditions, our surviving strike force will be adequate to retaliate both instantly and decisively to aggression.

Fortunately, the complex technological problem of insuring the survivability of SAC's alert forces in a missile attack can be solved, at least partially, through a basically simple military tactic, namely, by keeping the alert aircraft in the air instead of on the ground. This tactic has been tested thoroughly and found to be entirely feasible. With adequate and timely preparations for meeting added demands for support, SAC can maintain an airborne alert long and effective enough to bridge what could otherwise become the most dangerous gap in our military posture since Pearl Harbor.

• *Atlas* **milestone**—In discussing . . . our strategic strike forces I have, so far, emphasized the manned bomber. I have done so because, for the present and some time to come, we must depend primarily on our manned weapon systems to carry out the strategic mission. But SAC is rapidly building up its missile capability and reached an historic milestone on the ninth of September last year when a SAC combat crew successfully fired its first operational *Atlas* ICBM. As the President pointed out in his State of the Union Message, this missile has proven equally successful in its last 15 test launches, with an accuracy of less than two miles.

I have little doubt that continued advances in missile design and techniques will further improve warhead yield, accuracy and reliability and that, eventually, we will have missiles in sufficient quantity, quality and variety to accomplish most of our strategic missions. In the meantime, however, we cannot afford to neglect, let alone shelve, our existing and well-proven manned bombers because SAC must always maintain a sufficient inventory of operational and combat-ready weapon systems to insure effective coverage of its target system at any time.

As missiles are phased into SAC's inventory, they will replace some of the older bombers which are ready to be phased out. But I want to make it clear that this cannot be done at a ratio of one-for-one because, contrary to widespread belief, one missile is not equivalent to one bomber with respect to strike capability, as reflected in nuclear yield and accuracy.

While bomber accuracies are measured in feet, those of missiles are still measured in miles. Of course, missile accuracies will improve but, over distances of 5000 miles and more, even dramatic improvements in guidance techniques cannot be expected to approach the standards possible with SAC's bombing systems and techniques. Lower accuracy can, to some extent, be offset by higher yield. Yet, the yield of a missile warhead, although far greater than that of the largest conventional bomb, is but a fraction of the nuclear payload of the bomber which, moreover, can carry a number of high-yield weapons to different targets.

An additional consideration that must be taken into account in comparing missile and bomber quantities is the fact that missiles are "one-shot" weapons while bombers can be "recycled" and used for as many missions as circumstances may require and permit. The point has been raised that manned bombers are so vulnerable to modern aerial defenses that only a relatively small number could be expected to penetrate to their targets and few if any of these bombers could be counted upon for a follow-on attack. It must be realized, however, that offensive techniques and tactics have profited from scientific advances as much as or, perhaps, even more than defensive techniques.

• **Attrition in perspective**—It is often taken for granted that today's . . . antiaircraft missiles and guidance methods would exact far higher losses than we suffered in our bombing operations during World War II. But if someone had tried, in the early days of that war, to predict the average attrition rate for tight formations of hundreds of bombers fighting their way through heavily concentrated flak and large numbers of fighters, he probably would have arrived at a very high estimate also. Yet, out of a total of about 530,000 heavy bomber sorties flown in World War II, only some 9500 aircraft were lost to enemy action, for an average attrition rate of less than 1.8 per cent.

I am not inferring that bomber attrition rates in a nuclear war would be anywhere that low. But neither do I believe that they would be anywhere as high as is sometimes claimed. In trying to predict bomber attrition rates, one of the most important contributing factors is frequently overlooked, namely, the unpredictable factor of tactics. I maintain that the commander and his tactics, more than anything else, determine the losses in any offensive action.

There are several other factors which should keep future attrition rates within acceptable limits despite continued improvements in antiaircraft defenses. As these defenses become more sophisticated, they must rely to an increasing degree on electronic systems which in turn, are susceptible to electronic countermeasures. Moreover, it should be borne in mind that attrition applies not only to the *offensive* but also to the *defensive*.

Throughout World War II, bombers generally disregarded the defenses because they were not considered worth attacking. However, if we should be forced into a nuclear war by an aggressor, the enemy's aerial defense system would become a priority target and would be attacked with the most effective countermeasure known today, namely, the hydrogen bomb. Each successfully dropped bomb would take out the defenses in a wide area and permit ever deeper penetration for successive bombers.

• **Potent marriage**—Penetration of enemy defenses will be further enhanced by . . . *"Hound Dog,"* a supersonic and very accurately guided air-to-ground missile with nuclear warhead. The B-52G bomber will carry two of these missiles—one under each wing—in addition to its regular nuclear payload. Tests with the *Hound Dog* have met all expectations. In fact, I had the pleasure of accepting the first production missile from the manufacturer about a month ago.

The *Hound Dog* will make it possible to attack the enemy's defenses from hundreds of miles away and thereby help the bomber to penetrate to its target. But this is only one of the advantages of the *Houng Dog* missile. Its primary significance lies in the fact that it will vastly increase the utility and flexibility of the manned bomber and permit a variety of new tactics, such as attacks on additional targets in different areas during the same mission.

I consider the B-52 and *Hound Dog* combination but the first step in the marriage of manned bomber and missile. The next step will be the use of the manned aircraft as an airborne and virtually invulnerable platform for air-launched ballistic missiles. It is, therefore, evident that SAC must continue not only to replenish its manned weapon systems but also to modernize

them so as to keep pace with technological advances.

The addition of the *Hound Dog* and, later perhaps, of air-launched ballistic missiles will greatly extend the useful life of the current B-52. But, eventually, it must be replaced by a more modern bomber, and I am hopeful that, by that time, we can put into operation the spectacular B-70 which is now under development.

• **Balanced force**—Modernization of the bomber force is (not) a stopgap . . . because, for the foreseeable future, there will always be need for manned weapon systems. This will be true, for instance, in missions which entail reconnaissance and on-the-spot decisions based on human judgment or for attacks on mobile and concentrated, well-protected targets. The missile, in turn, will ultimately be assigned to most other strategic missions, especially those requiring rapid action and invulnerability to aerial defenses. This is why SAC is planning for an aerospace force of bombers and missiles in which one will complement and supplement the other . . .

The survivability of the missile poses a somewhat different problem from that of the bomber and must, therefore, be solved by different techniques. Since a missile cannot be recalled once it has been launched, it would be too risky to fire it until there is incontestable proof of aggression. Therefore, our ICBM's probably would have to "ride out" the initial attack. This problem is taken into account in our later missiles which will permit launching from silos deep in the ground, thus providing good protection . . .

• **Hardening gains**—Hardening . . . is both practical and highly desirable as it aggravates an aggressor's problem of destroying all or most of our missiles before they can be launched . . . Compared to the previously mentioned average of only three missiles needed for a 95% probability of destroying one soft missile site, the aggressor would have to launch a considerable number of missiles of more advanced design to obtain the same degree of probability that he can destroy one hardened site.

The aggressor's problem will be further compounded as increasing numbers of missiles are added to our operational inventory and placed in widely dispersed, hardened sites. The *Minuteman*, a greatly simplified missile now being developed for SAC, will be particularly suitable for this purpose. Additionally, it is planned to mount a number of *Minuteman* missiles on railroad cars and move them in a random pattern over the almost 100,000 miles of railroad trackage in this country which is suitable for this purpose.

Mobility is a most attractive defense tactic because the probability of destroying a mobile target with a long-range missile is extremely small. The advantages of mobility are fully exploited in SAC's airborne alert system and also underlie the basic concept of the *Polaris* weapon system. Mobile *Minuteman* missiles and bombers on air alert will have the added advantage of being beyond the reach of Soviet reconnaissance and countermeasures.

The concept of launching small medium-range ballistic missiles from a submerged submarine represents a most intriguing approach to the problem of survivability, despite the many unprecedented and still unresolved problems which it entails. We have great hopes for such a system but we also must remember that there are some inherent limitations as is true for any other type of weapon system. Also, it can be assumed that many if not most of the close to 500 submarines credited to the Soviets would be used to support a missile attack on the United States with simultaneous attacks on our nuclear fleet units on and under the seas. The *Polaris* must be prepared to cope with this threat.

• **Praise for *Polaris***—These limitations should not detract from the fact that the *Polaris* concept holds considerable promise. I am confident that, once the *Polaris* submarines have become operational, they will add importantly to our retaliatory capability, and I hope that their target systems and schedules will be integrated effectively . . .

As this and our other programs for the future materialize, we will reach the point where no foreseeable magnitude and method of attack can destroy the effectiveness of our retaliatory capability . . . Conversely, however destructive our capacity for counterattack, there can be no doubt that, by that time, the Soviets will have achieved a similar degree of survivability for their follow-on strike forces.

This means that both sides will have the capability of inflicting tremendous damage on each other's civilian establishment and economy, but neither side will be able to prevent the other from striking back. We will then have arrived at a condition which is best described as "nuclear impasse" since that is as far as we can go in stabilizing the global balance of military power. It is important to understand that this condition will be much more stable than the one in which we find ourselves today and which is usually referred to as "nuclear stalemate."

The term "nuclear stalemate" has created much confusion because it infers that, in effect, the Soviets' and our nuclear capabilities cancel each other out and that, therefore, they would not dare attack us. But there can be no real stalemate as long as the Soviets are in a position to tip the scales in their favor merely by taking the initiative.

However, once we have reached the point where a surprise attack can no longer prevent or even minimize retaliation, the initiative would give a potential aggressor only a temporary and relatively limited military advantage which would gain him too little and cost him too much to make aggression worthwhile. Our future security demands that we reach that point as rapidly as possible, rather than stretch out defense programs designed to get us there before it might be too late.

This should not imply that we will have reached the ultimate in destructiveness of weapons and compression of time. It would be futile to speculate what miracles of science and what technological breakthroughs lie ahead and what they might do for the battles of tomorrow, ranging from the depths of the oceans to the far reaches of space. But there can be no doubt that we can maintain an effective deterrent only by making certain that no other country will ever reach the next higher technological plateau before we do . . .

J. Paul Walsh: Formerly deputy director of Project *Vanguard,* and systems manager for special projects at IBM's Federal Systems Division, joins C-E-I-R, Inc., as director of the Space Weapons Systems Division.

Dr. Walsh directed the operation that launched the first *Vanguard* satellite into orbit; later joined IBM as manager of the Navy marketing program in the Military Products Division. He spent 15 years with the U.S. Naval Research Laboratory participating in Operation Crossroads; conducting research projects on reactor compartments for the Nautilus and Sea Wolf. Operation Wigwam earned him the Meritorious Civilian Service Award.

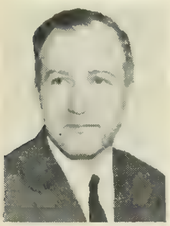

WALSH

Richard A. Rossi: Formerly reactor physicist and assistant chief of AEC's Lockland Aircraft reactors operations, joins Cross-Malaker Laboratories as a senior engineer.

Frank K. Clark, Jr.: Appointed chief engineer at M. C. Jones Electronics Co., Inc., a subsidiary of Bendix Aviation Corp. He joined the Bendix Radio division in 1954.

Lawrence F. Boland: Former vice president, elected to the newly created position of executive vice president of The Beryllium Corp.

He is a director of the parent company as well as a director of Nonotuck Manufacturing Co., a wholly-owned subsidiary, and of Consolidated Beryllium, Ltd., a firm jointly owned by The Beryllium Corp.


BOLAND

Robert J. Tatge: Named manager of flight and electronic systems; **Henry N. Titzler**, manager, missile systems; **Raymond J. Gambon,** manager, environmental systems; and **Ernest A. Wilder,** manager, heat transfer, at AiResearch Manufacturing Division, The Garrett Corp.

Tatge, with the division since 1950, was formerly manager of central air data computing subsystems; Titzler was previously manager of contract administration; Gambon and Wilder transferred from Garrett sales offices in Atlanta and San Diego, respectively.

John P. Jasionis: Named technical operations manager of the research laboratory for the Electron Tube division of Litton Industries. Jasionis joined the firm after 13 years with Sylvania Electric Products.

Sidney Gerhard: Appointed chief engineer, Propulsion Test Facilities, a division of MB Electronics, a division of Textron Electronics, Inc.

Was previously chief engineer, test equipment division, Consolidated Diesel Electric Corp., and chief project engineer, hydraulic test equipment, Greer Hydraulics, Inc.

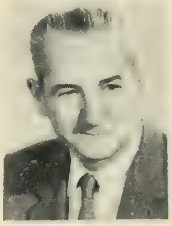

GERHARD

Dr. P. S. Christaldi: Joins G-V Controls, Inc., as manager of engineering. Was formerly product manager, Nuclear Systems, for Curtiss-Wright Corp.

Roy H. Lynn: Recently retired USAF lieutenant general, appointed president of ITT Communication Systems, Inc.

Arthur J. Wiltshire: Formerly chief engineer, Apex Reinforced Plastics, named chief project engineer at Structural Fibers, Inc., manufacturers of reinforced plastic and premix plastic products.

Notable achievements: development of the high-pressure bottle still used in conjunction with jet engine starters and ballistic missiles, and the MK. 32 torpedo launcher used in firing tracking-type missiles from surface ships.


WILTSHIRE

Lyle A. Backer: Named executive vice president of Thermal Controls, Inc. and O. K. Electronics, in charge of all operation from design to final delivery.

Kenneth L. Sayre: Joins Bjorksten Research Laboratories as senior project leader in the Organic and Plastics division. Was formerly with **B. F. Goodrich** Chemical Co.

Robert F. Leinicke: Joins McCormick Selph Associates' R&D technical staff as group leader for design and development of cool gas generators.


LEINICKE

Robert S. Camera: Capt. USN retired, joins Piasecki Aircraft Corp. as executive engineer in charge of the engineering department.

Raymond B. Slaney: Named manager of Space Technology **Laboratories, Inc.'s** operations planning department. Prior to joining STL in 1956, was assistant to the general manager at National Cash Register, electronics division.

Morgan E. McMahon: Elected manager of the engineering department Pacific Semiconductors, Inc., succeeding **R. A. Campbell,** recently elected vice president in charge of operations. McMahon, who formerly served as manager of product engineering, will direct overall department activities, with special emphasis on the transistor program.

Elmo E. Maiden, manager of special products was named assistant manager with special responsibility for the micro-electronics program and establishment of the micro-diode plant.

Clyde Skeen: Joins Temco Aircraft Corp., as executive vice president and general manager. Was formerly vice president for weapons system program management at Boeing Airplane Co. Aerospace division.

Dr. Joseph Neustein: Joins Electro-Optical Systems, Inc., as head of the advanced power systems department of the Energy Research Division.

Previous posts: Manager of engine research at Aeronutronic division of Ford Motor Co.; U.S. Naval Ordnance Test Station and an aeronautical research scientist with the National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory.

Daniel E. Murphy: Appointed director of Consolidated Electrodynamics Corp.' Datalab division. He joined the division in 1958 as administration manager.

George Singer: Formerly general manager of the microwave division of Kearfott Co., Inc., elected director of marketing and contracts for the Ranted Corp., producers of microwave products and waveguide components.

Andrew J. Kutler: Formerly assistant plant manager at ERCO division of ACF Industries, joins Fairchild Engine and Airplane Corp.'s Astrionics division, as program manager of simulation devices.

The Martin Co.-Baltimore announced the reorganization of its Information Services into three sections, News Bureau, Promotion/Publications and Community Relations:

Fred E. Hamlin, information services manager the past year, is now director of a comprehensive program which includes promotion and publications in addition to the department's previous functions of community relations and news media services.

Beverley L. Britton, who joined Information Services last May after 16 years as Navy public information officer heads the News Bureau.

John T. de Visser, who joined the firm in 1956, manages Promotion/Publications.

Kenneth D. Engle, who joined Martin in 1946, heads Community Relations.

—when and where

FEBRUARY

irst National Symposium on Nondestructive Testing of Aircraft and Missile Components, sponsored by Southwest Section, Society for Nondestructive Testing, and Southwest Research Institute, Hilton Hotel, San Antonio, Tex., Feb. 16-18.

hird Annual Missile/Space Industry Conference, National Rocket Club, Sheraton Park Hotel, Washington D.C., Feb. 16-17. **(Dr. Robert H. Goddard Memorial Dinner,** Feb. 17.)

IEE Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia, Feb. 18-19.

ational Society of Professional Engineers Winter Meeting, Broadview Hotel, Wichita. Kan., Feb. 18-20.

merican Institute of Chemical Engineers, Biltmore Hotel, Atlanta, Feb. 21-24.

ngineering Materials & Design Exhibition, Industrial and Trade Fairs, Ltd., Earls Court, London, Feb. 22-26.

ational Association of Corrosion Engineers, Tulsa Section, 11th Annual Corrosion Short Course, Mayo Hotel, Tulsa, Feb. 24-26.

MARCH

avy League Seapower Symposium, Sheraton Park Hotel, Washington, D.C., Mar. 1-3.

SME Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, Mar. 6-9.

eat Transfer Symposium, Mechanical Engineering Dept., University of Florida, Gainesville, Mar. 7-8.

ociety for Aircraft Material and Process Engineers, Midwest Chapter Symposium, Miami Hotel, Dayton, Ohio, Mar. 9-10.

echanical Properties of Engineering Ceramics, North Carolina State College School of Engineering and Office of Ordnance Research, U.S. Army, N.C. State College, Raleigh, Mar. 9-11.

ational Flight Propulsion Meeting, Institute of the Aeronautical Sciences (classified), Cleveland, Mar. 10-11.

lectronics Industries Association, Defense Planning Seminar, Statler Hilton Hotel, Washington, D.C., Mar. 15.

ymposium on Optical Spectrometric Measurement of High Temperatures, sponsored by University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation, University of Chicago, Mar. 23-25.

2nd Annual American Power Conference, sponsored by Illinois Institute of Technology, American Society of Mechanical Engineers and others, Sherman Hotel, Chicago, Mar. 29-31.

APRIL

niversity of Connecticut Sixth Annual Advanced Statistical Quality Control Institute, Storrs, April 3-15.

olar Energy Symposium, sponsored by American Society of Mechanical Engineers and Mechanical Engineering Dept., University of Florida, Gainesville, April 4-5.

1960 Nuclear Congress: "What Will the Future Development of Nuclear Energy Demand from Engineers?" sponsored by 28 engineering, technical, scientific and management organizations. Includes 6th Nuclear Engineering and Science Conference, 8th NICB Atomic Energy in Industry Conference, 6th International Atomic Exposition, New York Coliseum, New York City, April 4-7.

American Chemical Society, 137th National Meeting, Cleveland, April 5-14.

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editorial . . .

Congress Begins Procurement Probe

Congress this last week began a series of hearings "to make full and complete studies of the procurement policies and practices" of the Department of Defense and the Armed Services.

Pursuant to Public Law 86-89, "such studies shall include examination of the experience of such departments in the use of various methods of procurement and the types of contractual instruments with particular regard to the effectiveness thereof in achieving reasonable costs, prices and profits."

Probably no action taken in recent years is of greater significance to the entire defense industry. "Reasonable costs, prices and profits" are the economic laws by which industry lives or dies.

The Congressional action just started had its inception last year when the Renegotiation Act was extended. At that time the Defense Industry tried unsuccessfully to prevent re-enactment. Failing in this, the Industry did succeed in getting Congress to agree to a study of both the Armed Services Procurement Act and the Renegotiation Act itself. It will be the first study of the Procurement Act since it was passed in 1947, followed by the Renegotiation Act in 1951.

That such a study is overdue has long been obvious. Both Acts were inherently measures passed when military procurement carried a heavy emphasis on production in large numerical quantities.

Times have changed and so has defense procurement. Orval R. Cook, President of Aerospace Industries Association, recently noted that research and development costs for many of today's major weapons have reached the point where they substantially exceed production costs. Obviously, contractual techniques and policies must be modified to serve this new concept of procurement.

Equally important is the need to put renegotiation into its proper perspective as an element of the procurement process—where it now is not.

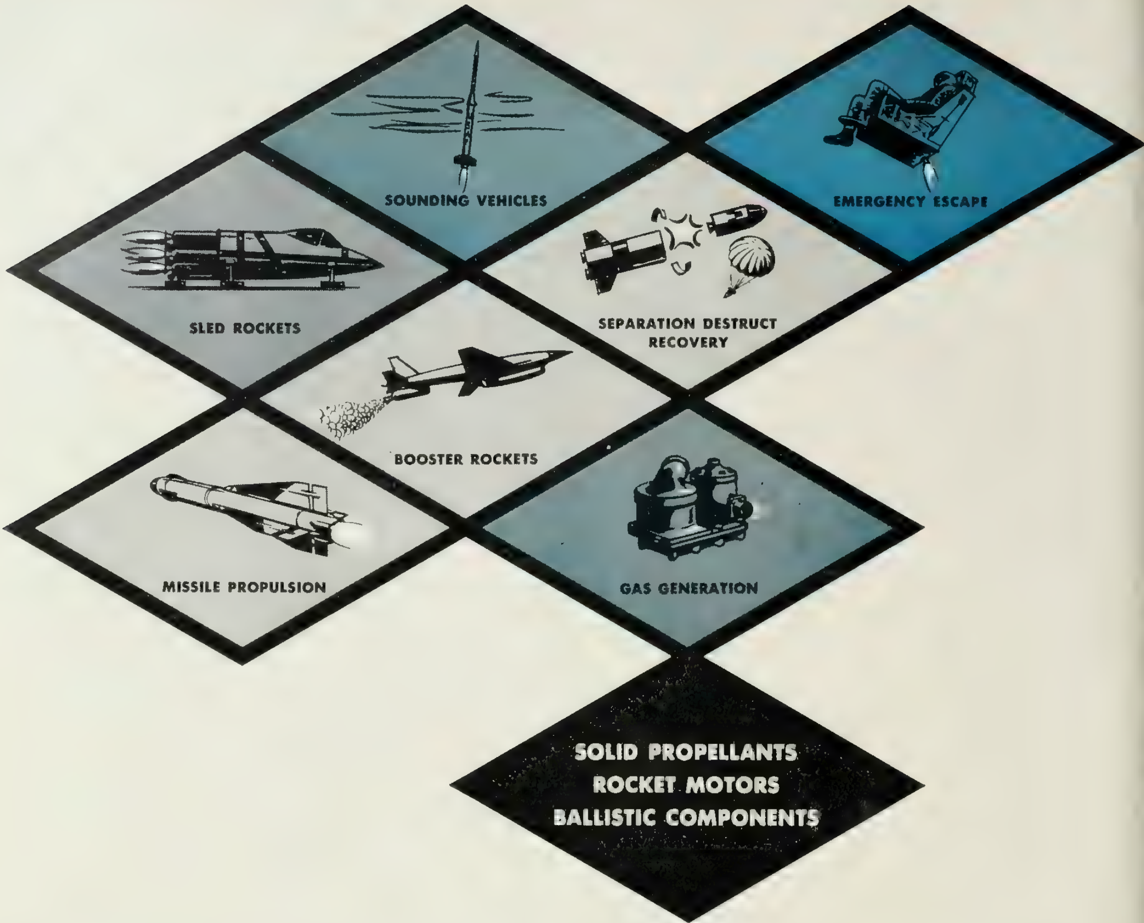
Under present procedures, the various departments of the Defense Department negotiate contracts under procurement laws designed to achieve reasonable "costs, prices and profits." They utilize contractual devices and techniques designed to provide the contractors with maximum incentive to reduce costs and prices.

Then what happens? Another government agency, the Renegotiation Board, moves in and determines whether these profits—honestly arrived at—are reasonable.

The first of the procurement hearings has been started by Sen. Strom Thurmond's subcommittee of the Senate Armed Services Committee. Following this, the House Armed Services Committee will begin its probe. The committees must report by Sept. 30. They will turn their findings over to the Joint Committee on Taxation, which will relate the data to the Renegotiation Act.

Regardless of what these hearings accomplish otherwise, they may achieve two things: (1) arouse the Defense Industry to the necessity of presenting its story jointly and forcefully to the Congress; and (2) convince Congress of the necessity of establishing one set of governmental policies to govern the procurement of defense production.

Clarke Newlon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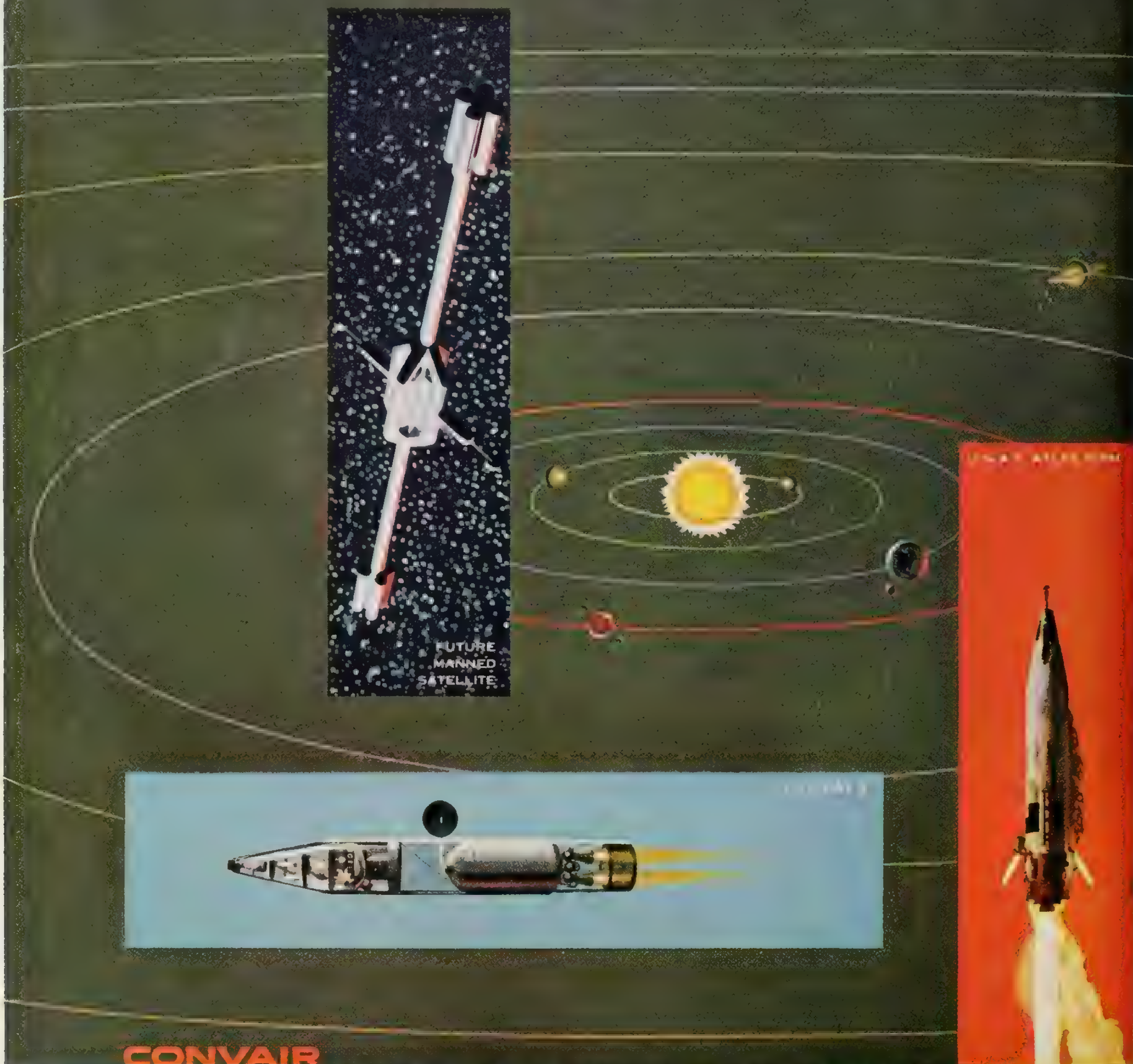

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Missiles and Rockets Volume 6 Number 8

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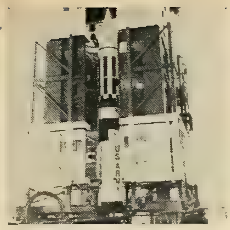


COVER: Martin *Pershing* surface-to-surface ballistic missile stands in gantry at Cape Canaveral, where it was first photographed during President Eisenhower's recent visit.

NEW duplexing filters being tested at GE's Syracuse plant, where radar is being built for the Ballistic Missile Early Warning System. In rear is a huge scanning-switch assembly. Picture story starts on p. 20.

VACUUM—insulated LOX semi-trailers deliver the vital fuel oxidizer to a missile at the Cape. They brought the liquid from nearby facility built and operated for Air Force by Air Products. See LOX story, p. 24.

'HARD SITE' launchers for AF's *Mace* are being built near tip of Canaveral. This is part of $28 million worth of construction under way at the Cape. Turn to p. 28.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

31,600 copies this issue

FEBRUARY 22 HEADLINES

ASTRIONICS

PROPULSION ENGINEERING

GROUND SUPPORT EQUIPMENT

ADVANCED MATERIALS

INTERNATIONAL

PRODUCTS AND PROCESSES

THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS

Washington Countdown

IN THE PENTAGON

Missile Gap Facts . . .

for confused Congressmen and taxpayers:

. . . *Atlases* are piling up at Convair's San Diego plant awaiting completion of operational bases. The backlog is running at more than two dozen birds.

. . . The San Diego plant is operating on about one and a half shifts a day. Production could be more than doubled.

. . . Base construction can be speeded up anytime the Administration wants to meet the bill. Less than five percent of the nation's construction capability is being used.

• • •

The *Zeus* drone program . . .

may be in jeopardy. The Defense Department is considering possible savings from using ICBM's launched in training exercises from Vandenberg AFB—rather than Chrysler *Jupiters*—during *Zeus* tests in the Pacific next year.

• • •

An anti-missile ray . . .

is beginning to look to some experts like a feasible bet in the years ahead. One proposal under consideration is aimed at perfecting a weapon that could destroy an oncoming missile at a range of 1000 miles.

• • •

NATO will decide . . .

which second generation solid U.S. missile, if any it wants to adopt as a NATO IRBM. The Joint Chiefs of Staff turned the problem over to the NATO nations after reaching a deadlock on making a choice itself.

• • •

The go-ahead on *Sky Bolt* . . .

R&D is a victory for the Air Force over the Defense Department. Pentagon R&E officials held up a decision on the development program for months after Douglas completed design studies.

• • •

The first *Midas* . . .

test satellite is expected to be launched by the Air Force at Cape Canaveral within a matter of weeks. The infrared early warning *Midas* system may eventually involve more than a dozen satellites.

• • •

Job description . . .

tagged by Air Force Maj. "Brandy" Griffith on his new assignment as Project officer for *Scout* at Cape Canaveral is "den mother."

ON CAPITOL HILL

A better break . . .

for small defense contractors will be the goal of a Senate investigation this spring. Senators are considering ways to shake up current Pentagon procedures for contract negotiation.

• • •

A breathing spell . . .

in the defense debate over missiles is expected to last for weeks in the Senate. The reason: the all-out Senate struggle over civil rights legislation.

AT NASA

Signals from the moon . . .

may be sent to the earth by a U.S. transmitter sometime in 1961. NASA will attempt to rough-land the transmitter in a 600-pound *Agena-B* payload. An *Atlas* will be used to launch it.

• • •

NASA's launching calendar . . .

for the next few months includes:

. . . A *Thor-Able* paddlewheel satellite to be launched toward Venus' orbit in late February.

. . . An *Atlas-Able* paddlewheel to be launched into orbit around the moon in April or May.

• • •

The first satellites . . .

to be launched from Wallops Island—America's third satellite launching base—will be boosted by *Scouts* this summer. One will boost into orbit a payload for testing the resistance of various materials to the impact of meteorites.

INTERNATIONAL

British missile cruisers . . .

London, Kent, Hampshire and Devonshire are scheduled to be equipped with surface-to-air *Seacats* and *Seaslugs*. Refitting will be completed by 1963.

• • •

The Iranian Army . . .

is considering purchase of Nord-Aviation's *SS-10* and *SS-11* antitank missiles. Iranian officials recently watched the French wire-guided missiles go through their paces at a demonstration at Mehrabad.

• • •

An Italian MRBM . . .

is under development by Sispre—the combine owned jointly by Fiat and Finmeccanica. Sispre also has a contract to produce the new 700-mile missile.

the missile week

Industry Countdown

MANUFACTURING

Helios is a nuclear . . .

rocket conceived by Convair's Krafft Ehricke as a means of leapfrogging Russia in space. *Helios* would have a takeoff weight of 1.8 million pounds and thrust of 2.4 million lbs. Booster of four liquid hydrogen-LOX engines would take the nuclear sustainer to more than 150,000 ft. before cutting loose. Dimensions of the vehicle: 250 ft. in length, 32 ft. id. *Helios* could put a 230,000 to 250,000 lb. payload in a 300-mile orbit—30,000 to 50,000 lbs. more than the proposed *Nova* chemical rocket which would have a takeoff weight of 4 million lbs. and thrust of 6 million lbs.

• • •

Cost of *Helios* . . .

is estimated at $1.2 billion to $1.5 billion. Ehricke said it could be developed by 1968-69 if adequate funding began in FY 1962.

• • •

Boeing is tapped . . .

to handle systems integration for the Douglas *Sky Bolt* ALBM. Other subs are Nortronics, GE and Aerojet.

• • •

Ceramic radomes . . .

are being brazed to the titanium body of *Bomarc B* by Boeing. The radome is nine ft. long and three ft. id.

• • •

New *Atlas* ICBM crew . . .

training center is being established at Sheppard AFB, Wichita Falls, Tex., by Convair and the Air Training Command. Ninety percent of combat missile crewmen will get their basic instruction there, with Chanute AFB carrying the balance. Crew integration and training shots will continue at Vandenberg AFB, Calif., (see M/R, Jan. 4, p. 12.)

PROPULSION

Aerojet appears the winner . . .

in the Air Force big solid booster contest. Company representatives have been invited to Edwards AFB to negotiate a contract. AF stressed that contract winner would have to share the cost of expanding facilities. Apparently Aerojet's bid called for a smaller AF payment than did the others.

Ignition of cut-grain . . .

Polaris motor after an underwater launch is scheduled by the Navy for the first time on April 20 off San Clemente Island. The missile will be powered just long enough to prove out ignition.

ASTRIONICS

Complete inertial guidance . . .

system for mobile ballistic missiles (presumably railroad-launched *Minuteman* ICBM) will be developed at AC Spark Plug's new Advanced Concepts Research and Development Laboratories, El Segundo, Calif. The new labs —electronic, optic and digital computer—are being dedicated Feb. 25. They are headed by H. L. Shulman, formerly of STL.

• • •

There's more unity . . .

among telemetry interests with the decision of the powerful Institute of Radio Engineers to rejoin the National Telemetering Conference. (Other members: AIEE, ISA, ARS and IAS.)

• • •

One for the calendar . . .

EIA's Defense Market Planning Seminar being held March 15 in Washington will have such panel members as Dr. Howard Wilcox, deputy director of DOD R&E; the director of the Navy's weapon systems evaluation group, Vice Adm. John H. Sides, and Dr. N. I. Korman, director of RCA's advanced military systems.

WE HEAR THAT

The Russians claim . . .

they have developed a new material—"Sital"—which is harder than carbon steel, lighter than aluminum and does not soften at 2552°F . . . Collins Radio is now participating in France's OMERA in association with a French radar company—Télécommunications Radioélectriques et Téléphoniques . . . Atlas Corp. has submitted a plan to divest itself of Summers Gyroscope stock . . . Signing of a $475 million contract by RCA now brings the total investment in BMEWS to more than $700 million . . . and Space Electronics Corp., Glendale, Calif., is working on a terminal guidance system for the *Titan* ICBM under a $96,000 contract with Avco.

Good Picture of Sandia

To the Editor:

We read your article ("Sandia Corp.: 1 Customer, 1 Competitor," by Frank G. McGuire, M/R, Jan. 18) with keen interest and full appreciation for the job you did under rather difficult circumstances. The comments I have received so far indicate that our people feel you have done the best job yet in describing our role in the weapons program.

We would like to have the permission of MISSILES & ROCKETS to reproduce the article for distribution to our employees and for selected use in recruiting . . .

T. B. Sherwin
Public Relations Supervisor
Sandia Corporation
Sandia Base
Albuquerque, N.M.

The comments are appreciated and permission has been granted.—Ed.

To the Editor:

As an engineer at Sandia's Livermore Laboratory, I was most interested in the article concerning Sandia.

Because of the nature of our work—most of it classified—it is difficult even to tell our children and relatives just what we do. Your article is the best we have seen.

Would it be possible to obtain a few tear sheets of the Sandia article? They would be greatly appreciated.

R. C. Wishart
1511 Sunny Court
Walnut Creek, Calif.

Copies are on the way.—Ed.

Twisters from Plasma Pinch?

To the Editor:

The article "Lightning—Future Red Weapon" (M/R, Aug. 24, p. 13) and a subsequent letter on the subject (M/R, Oct. 5, p. 50) were instrumental in starting this writer on a quest for knowledge on pinched plasma phenomena, a subject covered in the comparatively new field of Magnetohydrodynamics.

Research into this field, particularly on the attempts by the AEC to attain controlled thermonuclear reactions, uncovered an interesting correlation between the raw materials, electric currents, voltages and induced magnetic fields of the controlled fusion attempts, and the conditions existing in "tornado"-spawning thunderstorms.

This correlation and considerable further research have led me to formulate a hypothesis that tornadoes may be the result of a pinched plasma phenomenon within such thunderstorms—this phenomenon caused by recurrent strokes of "ionizing" lightning in a particular area over a relatively short period of time.

Eyewitness accounts over a period of years have contained reports of intense illumination, crackling electrical discharge sounds, and peculiar odors of sulphur, brimstone, ozone, etc., during and after the passage of tornadoes. One such report included the sighting of balls of orange fire being thrown out of the tornado center and then exploding into smaller gobs of fire particles.

This writer intends to investigate this theory through the Oklahoma State University Tornado Laboratory during the Spring of 1960 and invites any and all opinions, loud guffaws, or supporting testimony on the subject.

L. L. Eppley, Jr.
810 West McElroy Avenue
Stillwater, Okla.

Haven for Incompetents?

To the Editor:

Permit me to congratulate you most sincerely upon your editorial "A Captive Small Business?"

Perhaps the subject matter of this editorial strikes me particularly forcibly because for some time I have been on the Ohio "National Board of Field Advisors," and have had some occasion to keep in touch with the activities of the Small Business Administration; and, in fact, to criticize some of these activities which I think are not in the true interest of, or representative of, the sound small business man.

Unfortunately, the SBA has been subject to the efforts of being used as a tool for speculative and incompetent people who frequently seem to feel that they are entitled to financing and help, mainly because they have been unable to get financing or run a successful business otherwise. In at least one instance of this sort, I interceded in Washington with some minor success; but I still have the feeling that this sort of thing occurs too often . . .

Paul C. Rodgers
President
Burton-Rodgers Inc.
Cincinnati, Ohio

TAC Procurement

To the Editor:

The Jan. 11 issue of M/R included an item on Tactical Air Command which seems to be an unfair criticism of our procurement policies. I refer to the statement in the column "Industry Countdown" which implied that TAC was not cooperating in the equipment standardization program by insisting on its own missile carrier loader. The reason stated for this was that the command "just wanted to be different."

Unfortunately the comment was so broad and indefinite that we could not tie it to any specific piece of equipment. In fact we could find no instance in which TAC's requirements for missile carriers or loaders were not satisfied by existing Air Force equipment.

I'm sure you realize that like other elements of the Armed Forces, we are working within a very tight budgetary limitation. To spend extra money for an item of equipment, "just to be different" would be a detriment to TAC as well as the Air Force. When this command does purchase specialized equipment, it is only after long study and with the firm conviction that no other equipment will do the job satisfactorily.

The integration of missiles and aircraft within Tactical Air Command is proceeding as fast as funding and the state of the art will allow. We would do nothing to jeopardize this progress and ask your help in accurately presenting our activities to the public.

Joseph A. Stuart, Jr.
Colonel, USAF
Information Officer
Tactical Air Command
Langley AFB, Va.

More on *Saturn* vs. F1

To the Editor:

We have watched with interest the confusion between the *Saturn* and the F-1 (Let the People Know, M/R, Dec. 28, and Letters to the Editor, M/R, Jan. 18). You cannot compare apples and oranges. The F-1 is an *engine* under development while the *Saturn* is an approved funded *vehicle* development.

Mr. W. G. Huber
2101 Fulton Drive
Huntsville, Ala.

Mr. C. H. Rutland
1019 Fairway Drive
Huntsville, Ala.

Mr. E. A. Weaver
406 Newman Avenue
Huntsville, Ala.

Rawlings 'Homecoming'

To the Editor:

I was quite pleased to see the article (M/R, Jan. 25) citing General Rawlings' speech which he made to our Dayton-Wright Chapter of Armed Forces Communications and Electronics Association on 14 January.

We were extremely happy to have General Rawlings "back home" for this occasion.

W. H. Shade
President
Dayton-Wright Chapter
Armed Forces Communications and Electronics Association
Room 412, 333 West First St.
Dayton 2, Ohio

NASA Tells of *Mercury*, Moon Plans

Schedule given Congress includes rough landing payload on moon in 1961

by Paul Means

National Aeronautics and Space Administration testimony before Congress last week revealed preliminary steps to be taken in the program for manned lunar flight, and more detailed information about the man-in-space Project *Mercury*.

Of particular interest were the space agency's plans to:

• Orbit a *Scout* payload this summer designed to test spacecraft materials' resistance to meteoritic impact;

• Launch a 600-pound *Atlas-Agena* payload in 1961, part of which will be rough-landed on the moon in working order to transmit information back to earth;

• Subject the *Atlas*-launched *Mercury* capsule to a variety of sub-orbital trajectories to provide complete qualification of the capsule and all of its systems.

NASA Assistant Director of Research Richard V. Rhode pointed out various problems which must be solved before manned rockets can go to the moon and return, and the specific NASA programs to overcome these problems.

Specific difficulties presently deterring lengthy manned flights, according to Rhode, are the hazard of meteoritic impact, and the problems of guidance and attitude of the spacecraft. He pointed to present work on the ground at Ames Research Center, which simulates meteoritic impact by firing small balls about 1/16-in. in diameter out of high-speed helium guns at speeds up to 14,000 mph.

This research, according to Rhode, has shown that one possible way of handling the meteoroid threat is to build a light shell or "bumper" around the spacecraft, on which the particles will disintegrate upon impact before striking the underlying structure. Results are even better, Rhode said, if the area between the two layers is filled with low-density glass wool. Tests at Ames show that particles going as fast as 7000 mph will be stopped by this type of structure.

• **Summer test**—First test in space of this theory will be this summer, when a *Scout* will launch a puncture-experiment satellite into orbit. The satellite will contain short tubes running lengthwise made of metal of various thicknesses, with gas under pressure. When a tube is punctured by a meteoroid, the gas will leak out and the information will be radioed back to earth.

NASA is attempting to solve the guidance and control problems of manned lunar flight, according to Rhode, by conducting research on highly sensitive sighting, or sensor systems. Such systems, which take as their reference point the lunar horizon or a star, must be accurate to within .005 degrees.

The third problem that must be overcome before manned lunar flight is possible, according to Rhode, is the lack of detailed information about the moon itself. Launches intended to overcome this problem include a moon orbiter by *Atlas-Able* in 1960, a rough landing by *Atlas-Agena B* in 1961, and soft landings by *Centaur* and *Saturn* within a few years.

Rhode described a spacecraft (see picture) under development by the Jet Propulsion Laboratory, which will be launched in 1961. The craft will weigh about 700 pounds and will be launched by an *Atlas-Agena B*.

This craft has two folding-vane solar energy collectors and a dish-type antenna which transmits and receives signals to and from the earth. The main body contains attitude control and navigation equipment, instruments and radios. At the top is a capsule that will be separated from the spacecraft proper and landed safely on the moon.

During the early phases of the flight, according to Rhode, injection and mid-course guidance are exerted. As the spacecraft approaches the moon, the small capsule is separated from the main spacecraft and retro-rockets are fired to slow the capsule's speed. The main spacecraft crashes and is destroyed. The small capsule lands on the moon, its impact energy absorbed by penetration spikes, and goes into operation obtaining data and transmitting it back to earth.

Testimony by George M. Low, chief of NASA manned space flight programs, gave more details about the instrumentation of the *Mercury* capsule, and the varied trajectories that will be used in connection with the *Atlas* test shots.

• **Panel**—The astronauts instrumentation panel (see photo next page) has sequence controls to the left of center, allowing the pilot to back up essentially every function that would normally be performed automatically. On the extreme left panel are switches used to lock out the automatic attitude control system, and to activate the manual control system. Then—by using the manual control stick, together with flight instruments—the astronaut can maintain the capsule in the proper orientation.

Another handle on the left-hand panel allows the astronaut to decompress the capsule in case of fire or a buildup of toxic gases. Venting the capsule to the outside vacuum will extinguish a fire or remove noxious gases, and a second handle will repressurize the capsule.

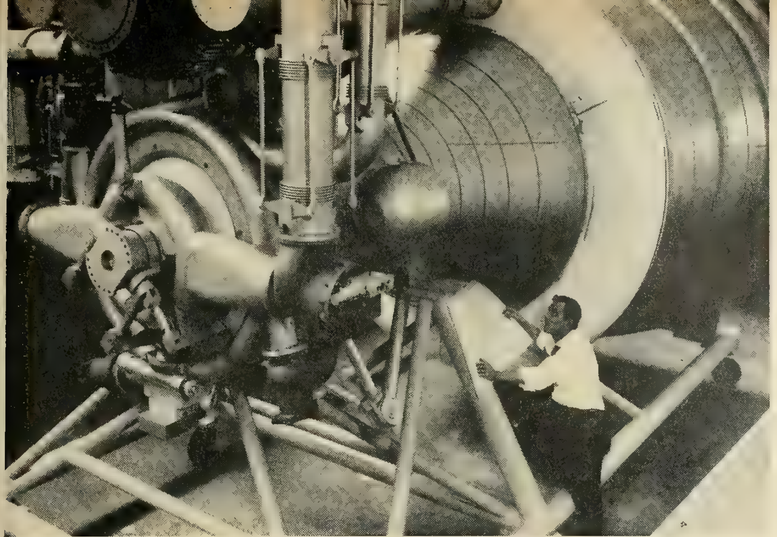
The panel on the right contains instruments and switches for the control of life-support, electrical and communication systems; and warning lights that indicate the malfunctioning of any of these systems.

Three types of trajectories, according to Lowe, will be used in qualifying the McDonnell capsule with the Convair *Atlas*. The first type will subject the capsule to the worst type of re-entry possible, with the capsule plunging back into the atmosphere from an altitude of 140 miles with a peak deceleration of 19 g.

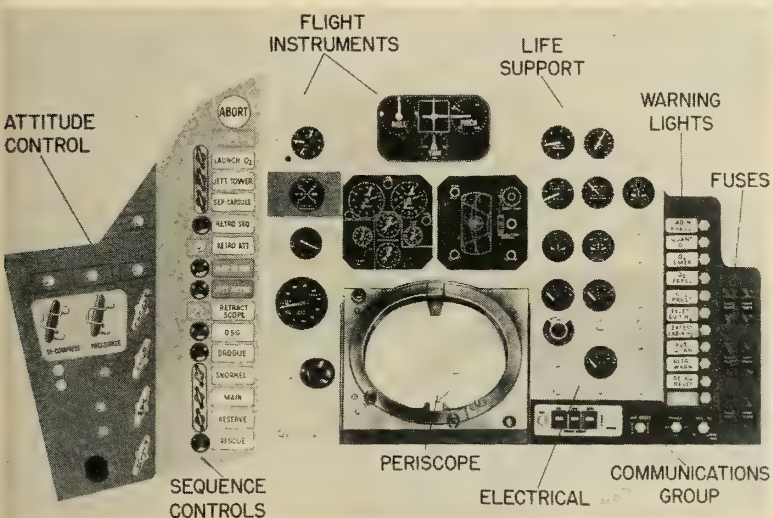
The second type of trajectory to be used will duplicate exactly the velocity, altitude and angle of orbital re-entry without actually going into orbit. Objectives of this trajectory are to qualify the capsule and its heat protection under actual re-entry conditions, and to determine the stability characteristics of the capsule and the functioning of the reaction control system.

The third type of trajectory will be one which actually inserts the capsule into orbit, but immediately turns it around and effects re-entry. During this flight, according to Lowe, an altitude of 120 miles will be reached and a range of 4000 miles will be attained. This flight will give the necessary operational experience needed before orbital flights can be attempted.

After these tests, the *Atlas*-launched capsule will be put into the final orbital trajectory, with instrument and primate tests leading to the final manned orbital flight.

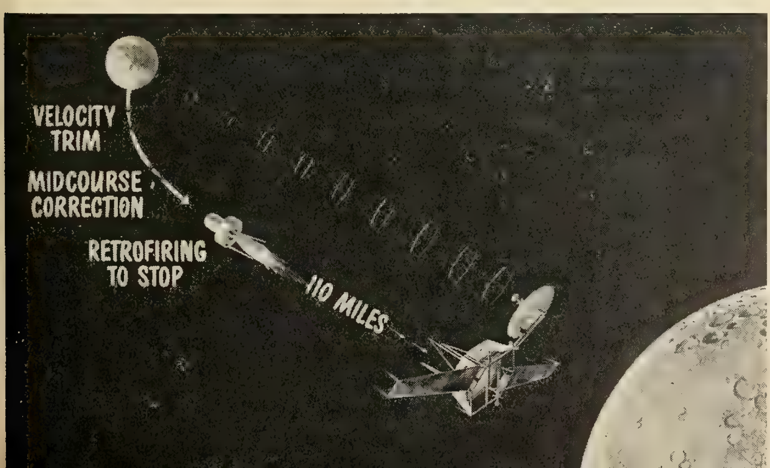


FIRST PHOTOGRAPH of North American's early full-scale mockup of its 1.5 million pound thrust F-1 engine was released last week by NASA.



ASTRONAUT'S PANEL in *Mercury* capsule allows attitude control with instantaneous visual presentation of vital flight factors.

ARTIST'S CONCEPTION of how hard landing would be made on moon using *Atlas-Agena* vehicle with midcourse guidance correction.



—news briefs—

• **London**—The British announced they will join the United States in construction of a third BMEWS station in Flyingdale Moor, Yorkshire—midway between London and Edinburgh. The other two BMEWS stations are under construction at Clear, Alaska, and Thule, Greenland.

• **Dahlgren, Va.**—The Pentagon continued to withhold the reason why the Navy kept secret from its sister services for more than a month the tracking of Unknown 1-60—the polar-orbiting mystery satellite popularly known as "Lonesome George." Meantime, sources disclosed that Navy's Spasur—the dark satellite detection fence—picked up traces of Lonesome George for weeks before even the Navy discovered it.

• **Washington**—Pentagon comptroller Franklin B. Lincoln, Jr., told the Senate Defense Appropriations Subcommittee that $2.2 billion of planned missile obligational funds in FY 1961 will be used for *Atlas, Titan, Polaris* and *Minuteman*. That is $600 million more than in FY 1960 and $900 million more than in FY 1959.

• **Washington**—Lt. Gen. Arthur G. Trudeau, Army R&D Chief, told the House Space Committee that *Nike-Zeus* antimissile-missiles could be operational before 1965 if the program had a "full blast" go ahead. However, Army Secretary Wilber Brucker said the Defense Department is considering a sizeable cutback in *Zeus* R&D funding.

• **Los Angeles**—Sen. Stuart Symington (D-Mo.) called for the unification of all U.S. space programs under one man who would report directly to the President. Symington said: "The exploration of space is America's new manifest destiny."

• **Hartford, Conn.**—The Pratt & Whitney liquid hydrogen-LOX engine has been burned as long as four minutes at 15,000 lbs. thrust, H. M. Horner, chairman of United Aircraft Corp., reported last week. Horner also told the Connecticut Editorial Writers Assn. that United's P&W Division accomplished six major developments in its indirect cycle aircraft nuclear propulsion program last year, although security forbids detailing their nature. Both the P&W indirect cycle unit and General Electric's direct cycle unit are to be tested soon at the National Reactor Testing Station, Arco, Idaho.

• **Wallops Island, Va.**—An *Aerobee-Hi* sounding rocket carrying a 150-lb. payload crashed into the Atlantic Feb. 16 after its second stage failed to operate. The NASA rocket was designed to collect data on micrometeorites in the upper atmosphere.

Siegler Moves Into Solid State Devices With Merger

The Siegler Corp. of Los Angeles is moving into production of equipment utilizing solid state devices, with a merger with Magnetic Amplifiers, Inc.

Magnetic Amplifiers products include flight control systems, commercial TACAN equipment, automatic checkout equipment, servo systems and speed controls. Siegler Co. is engaged in military and commercial electronics, heating, and cooling equipment and specialized machinery.

• **In other important mergers**—Gorham Manufacturing Co. has acquired all the assets of Pickard & Burns, Inc., prominent in electronic navigation, communications and radar systems and instrumentation. Gorham also has recently formed an R&D group and is expected to increase its defense role appreciably.

Dynex, Inc.'s president announces that the Optics Manufacturing Corp. has become a wholly-owned subsidiary. Anaheim Electronics Co., Inc., has been purchased by the Electronic Engineering Co. of California. A new insulated wire firm enters the missile scene with the formation of Irradiated Insulations, Inc., by Carlisle Corp. and Radiation Applications, Inc. (an affiliate of Schenley Industries, Inc.).

Olin Mathieson Chemical Corp. and Pennsalt Chemicals Corp. are joining forces in an equally-owned joint subsidiary, to be known as Penn-Olin Chemical Co. The $6,500,000 venture will produce sodium chlorate and other chlorate compounds.

Articles of incorporation are on file for Astro Components Corp., a new research and development firm for explosives and rocket fuels in Albuquerque, N.M.

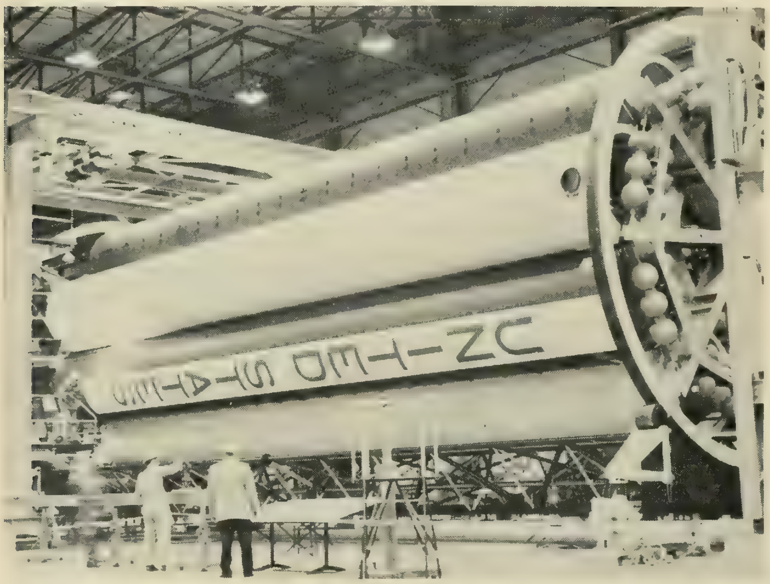
• **Building and expanding**—Sylvania Electric Products, Inc. is planning a new electron tube research and development center at Emporium, Pa. A new environmental testing facility for missiles is now in operation by Associated Testing Laboratories, Inc. The Martin Co. has a big contract with the Orlando, Fla., center, but it is available for other prime and subcontracting firms in the Southeast.

Litton Industries is expanding its electron tube division with a $2-million addition to its Industrial Road, San Carlos, Calif., building. Sperry Utah Engineering Lab will have a new $1,200,000 office building by July 30.

A new California manufacturing plant is planned by the Computer Division of Bendix Aviation Corp., increasing its Los Angeles facilities by 70%.

Realigning structure, Royal Industries, Inc. changes its corporate structure from a parent company with four subsidiary corporations to a single company with four divisions. The divisions are Vard, formerly Vard, Inc.; Audiotone, formerly Audio Company of America; Royal Jet, from Royal Jet, Inc. and Ideal-Aerosmith, from Ideal-Aerosmith, Inc.

Saturn's Fabrication Progress



ENGINEERS use optical instruments to make final assembly alignment checks on 22-ft.-diameter *Saturn* booster at Redstone Arsenal. This photograph, released by the Army last week, shows good fabrication progress since M/R published first exclusive photographs of *Saturn* assembly (Feb. 8, pp. 14-18). Three-stage system will be about 200 ft. long. Center LOX tank has length of 625 in. and 105-in.-diameter. Eight other LOX and kerosene fuel tanks have 70-in.-diameter and 675-in. length.

Ames Studying New ICBM Detection Method

MOFFETT FIELD, CALIF.—Possibility of a new, completely passive detection method for intercontinental ballistic missiles is under study here at Ames Research Center of National Aeronautics and Space Administration. The center is currently studying a theory which holds that radio frequency energy is generated by a high-speed body, and that this energy is detectable by a passive receiver.

Answers being sought by scientists at Ames would indicate the validity of the theory; what frequency ranges are involved; intensity of the energy; and how velocity, altitude, density and other variables would affect the phenomenon.

Ames officials strongly emphasize that the research is in its earliest stages and no significant results have been obtained. High-speed projectiles are being fired from one of the air-guns at the research center as part of the program. Presumably, the effect would take place only in the atmosphere.

The work stems from a theory dating back to 1914, when it was noted that persons sometimes heard a meteor before seeing it. It was then theorized that the high-speed body generated radio waves which were made audible by a metallic object near the witness. (Cases have been known wherein stoves, beds and even false teeth have picked up radio stations.)

In similar work in the same field, Lincoln Laboratory of Massachusetts Institute of Technology is probing the wakes of high-speed bodies with microwave beams to determine the reflectivity and transmissivity of the ionized particles in the wake. This would provide another means of detection and tracking.

NATIONAL ROCKET CLUB President Nelson P. Jackson opens up Third Annual National Missile/Space Conference at panel on "Space Challenge—Philosophy." Among panelists: Rear Adm. Thomas F. Connolly, Deputy Chief, Bureau of Weapons; Ernest Lindley, Newsweek Magazine, and Dr. Donald Michael, Brookings Institution.

Space: Place For Future Wars

Missile/Space Conference hears pleas for 'adventurous' DOD space program

by William E. Howard

Military and industry leaders urged the United States last week to take an "adventurous" approach toward space—with the high hope of removing future wars from this planet.

Speakers and panelists told the National Missile/Space Conference in Washington that lunar and cislunar space—by their vast distances—offer a means of preventing "ethnicide" by relieving the almost instantaneous response time being built into U.S. and Russian ICBM's.

The two-day conference was climaxed by the third annual Dr. Robert H. Goddard Memorial Dinner and the award of the Goddard Trophy by MISSILES AND ROCKETS MAGAZINE to Karel Jan (Charley) Bossart for his outstanding contribution to the development of the Convair *Atlas* ICBM. M/R Executive Editor Clarke Newlon made the presentation. Other awards:

• The Borg-Warner Missile Industry Award was presented to Thiokol Chemical Corp.'s Reaction Motors Division for its successful development and production of prepackaged liquid engines, the Guardian I and Guardian II, used in the *Sparrow III* air-to-air missile and *Bullpup* air-to-surface missile.

• The Astronautics Engineer Achievement Award was presented to Richard B. Canright, chief of research at Douglas Aircraft, by the National Rocket Club for his contributions to the *Saturn* and *Centaur* booster programs and the 1.5-million-lb.-thrust rocket engine projects.

• **'Leapfrog' proposal**—The conference sponsored by the National Rocket Club also heard Dr. Krafft A. Ehricke of Convair assert that a combination nuclear-chemical rocket offers the U.S. a "real good chance to leapfrog" the Soviets in space. He said a well-financed start in FY 1962 could see a huge *Helios* rocket developed by 1968-69 (see p. 8, this issue).

Ehricke said he believes the Russians will try to send a scientific payload to Mars in August. The German-born scientist suggested that *Lunik III*, which photographed the farside of the moon last October, may have been a test flight of the "interplanetary station" the Soviets will use in a Mars shot.

• **Making a choice**—Some of the harshest criticism of the nation's space effort came from Dr. Arthur Kantrowitz, director of the Avco-Everett Research Laboratory, who declared that the Eisenhower Administration has decided unequivocally that "we are not competing with anybody" in space.

Likening the mastery of space to a "genie," Kantrowitz said:

"When the genie presents you with the wishes, among which you may choose, if you choose comfort—and typical of the comfort wishes is the program for a balanced budget with no new taxes—you may get the comfort for a while.

"If you choose the adventure (of going into space) it is one of the firmest facts of our experience that in the long run we get more comfort and luxury than by choosing comfort in the first place. And so this brings us to the point where we can see how to live happily ever after."

Ticking off surveillance, weather, communications and astronomical satellites as truly important space programs now in progress, Kantrowitz predicted

answer to population problems?

COFFEE BREAK brought together Col. Charles I. Davis, Industrial College of Armed Forces; Navy Capt. F. M. Sanger, Jr., Weapons Program System, Office of Naval Material; C. E. Pritchett, assistant Superintendent of Sales, Western Electric; and Dr. James H. Trundock, Jr., of IBM.

that with progress the cost of putting a pound of payload into space will be about $100—comparable to the cost of making airplanes.

"We are very quickly going to reach the situation where we can put into space numbers of objects comparable to the number of airplanes we can buy. This gives us a tremendous opportunity for invention," he said.

Space technology, Kantrowitz said, can help make the U.S. retaliatory force secure "so that we need never contemplate the necessity of its hasty employment." Distances available in space "can be translated into times, thus it will take days to reach and destroy an object at the distance of the moon. We can, by using these distances, acquire precious time in which to make the fateful decision of unleashing our retaliatory force."

• **Easing population**—He suggested that space also may be the solution to the population pressures of an earth made "too small a place for mankind" by nuclear weapons. "The power of nuclear weapons in the present situation where it is possessed by four nations creates a very dangerous situation. When nuclear weapons are possessed by 40 powers I am not sure that the situation will be tolerable," he added.

The physicist said the population explosion could be solved by colonizing the moon or other planets, but he felt living in space itself—presumably on a city-like space station—would be more attractive. "This would be a larger departure from earthly living than moving to another planet."

Kantrowitz also attacked the development program of NASA, charging that the civilian space agency was spending hundreds of millions of dollars in-house "and only $4 million outhouse" in research.

• **New ARDC program**—A new Air Force program aimed at reducing the overlapping of scientific effort by keeping persons in the field up to date with their colleagues was outlined to a marketing panel by Lt. Gen. Mark E. Bradley, Jr., deputy chief of materiel. Called "CATE" for Current ARDC Technical Efforts, the program is basically a directory of scientists and engineers working in all technical areas and where they can be contacted. It will begin in March.

Indicating there would be no major changes forthcoming in the manner in which the Air Force does business, Bradley did however make these points:

• The AF intends to build up its "organic" capability to a "plateau so that we will be in a better position to control, direct, change and review our projects" to strengthen its management controls.

• The tremendous cost of space vehicles will "necessitate the procurement of relatively few end items and will dictate a degree of reliability which we are presently not enjoying."

• There is a major requirement for development of a recoverable space booster.

• R&D ground environment for space weapon systems should be constructed with a view in mind of subsequent utilization by the operational command. This could mean "significant savings."

• **Military role stressed**—Canright, a former ARPA official, said "the United States could win a war in space." He told a panel discussing the "philosophy" of the space challenge that AICBM's—"missile destroyers"—could force the Russians into space and thus avert a war on earth which would—if it started—amount to an "international suicide pact" or "ethnicide."

Rear Adm. Thomas F. Connally, assistant chief of the Bureau of Naval Weapons for the Pacific Missile Range, declared that it "would be folly to keep the military out of space."

One dissenter on this panel was Rep. James G. Fulton (R-Pa.), who said this country and Russia should cooperate in space and not operate there by the "law of the jungle." Referring to the Russians as "wonderful people—and we must treat them as human beings," the Republican Congressman conceded, however, that the Russians may present a military threat in space overnight. Therefore, "the military must be alert to space operations and must stay involved in them."

Fulton was taking issue with a statement by Andrew G. Haley, general counsel of the American Rocket Society, after he said:

"At the present time, only one certain, essential and positive issue actually is before us: 'Who controls the moon controls the earth'."

Haley added that it was the "clear duty" of the national leadership to use every means, including war, to prevent an alien power from controlling the moon. Foley said this would be reducing a scientific area to "law of the jungle."

• **Plea for firm requirements**—The president of Consolidated Diesel Electric Corp., Norman I. Schafler, speaking on the marketing problems of medium-sized companies, said:

"We would like to see the prime contractors firm up their 'make or buy' decisions before requesting proposals from prospective suppliers."

He said there are too many cases where very detailed and costly proposals have been submitted to primes when the program is later altered or the "prime contractor elects to build the item himself." Another sore point, said Schafler, is the need for a better way to advise industry of the requirements of weapon system managers. Not being able to afford large sales staffs to become acquainted with needs of all the big contractors, he said, smaller companies either have to concentrate on a small portion of the field or try to cover all of the contractors partially.

Schafler suggested that a system of posting requirements would be a solution to the problem.

• **Belt tightening**—Another panel member, Donald E. Perry, managing editor of MISSILES AND ROCKETS, expressed doubt that any new missile or space programs would be "sold" during the remainder of this election year. Instead of being a new business year, Perry said, 1960 would be remembered as "Product Improvement Year" by the industry. He predicted increased belt tightening "as contracts get fewer and fewer and competition gets stronger and stronger . . ."

• **In to win**—There is no point in changing the nation's existing space set-up, Sen. Thomas J. Dodd (D-Conn.) told a legislative panel, "unless there is a decision by the President and his Administration and by the Congress that the United States is going to get into this space competition with the single objective of winning it."

He said "we have got to make a national decision that we will not continue to play second place." It is Dodd's position that such a national decision should be made and we should "spend the money and make the effort necessary to do so."

On the question of whether the missile/space issue should be injected into the forthcoming presidential political campaigns Dodd said he is against partisan bickering, but it is a function of the American system of government to publicly examine the adequacy of these programs.

"If our space and defense programs are adequate, if we are doing all that we could and should do in these fields," he said, "then public discussion can only continually remind our friends and opponents in the world of our indisputable strength and rapid progress. It is only when our programs are deficient that public discussion of these deficiencies is embarrassing—both to our leaders and to our country."

The Connecticut lawmaker—referring to the raging controversy over the Missile Gap—said "most of the complaints about public airing of these issues have as their objective saving the Administration, rather than the country, from embarrassment."

REP. James Fulton (R-Pa.) and Dr. S. Fred Singer, University of Maryland, discuss pending panel program on "Space Challenge."

REGISTRANTS sign-up for four panel discussions and Third Annual Dr. Robert H. Goddard Memorial Dinner. Right, Andrew G. Haley, past president of International Astronautical Federation.

Rover Gets More Spending Authority, No More Money

The Administration has upped its authorization for spending on the Project *Rover* nuclear rocket in the 1961 fiscal year but no more money was allowed, Sen. Clinton P. Anderson (D-N.M.) reported last week.

Anderson, chairman of the House-Senate Committee on Atomic Energy, said the Budget Bureau took the action after an appeal for more funds by John A. McCone, Chairman of the Atomic Energy Commission.

Anderson made the disclosure in a statement issued after his committee held a one-day closed hearing on the status of *Rover*. Here, Anderson said, is what happened:

The AEC requested $20 million in FY 1961 for construction of test facilities for *Rover*. President Eisenhower, at the recommendation of the Budget Bureau, cut this to $13 million.

At the same time, the Administration ordered a slowdown in the *Rover* testing schedule. The first ground test of the rocket was moved back from 1963 to 1964. The first flight test, which had been set for 1965 or 1966, was rescheduled for the period 1968-69.

After McCone's appeal, the Budget Bureau raised the AEC spending authorization to $20 million, as originally requested. However, the actual appropriation requested from Congress was not changed. The AEC was told that it might shift some funds to *Rover* from somewhere else if it wished to do so.

Project *Rover* is jointly administered by the AEC and the National Aeronautics and Space Administration.

Preflight Testing of New X-15 Engine Completed

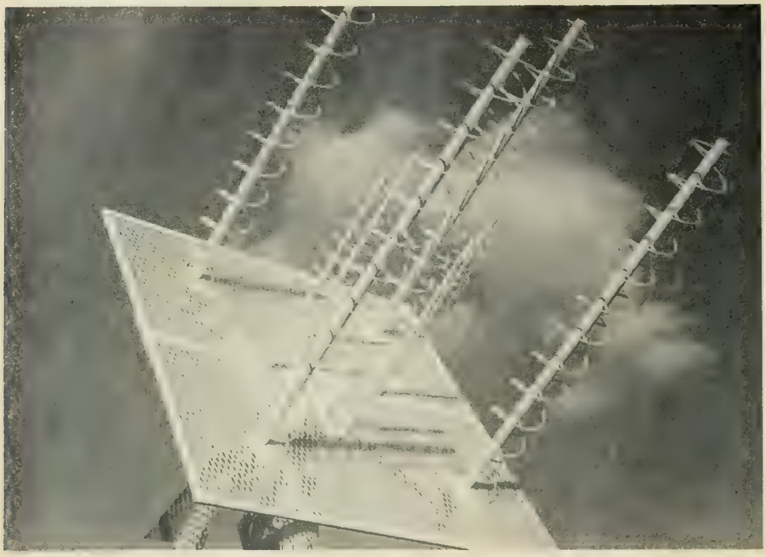
All tests in the Pre-Flight Rating Test program on the high-thrust *X-15* rocket aircraft engine have been completed, Reaction Motors Division of Thiokol Chemical Co. has announced.

Thiokol said this means the U.S. now has a fully throttleable rocket engine for manned flight with control exercised at the pilot's discretion.

The new engine, designated *XLR-99-RM-1*, provides more than 50,000 lbs. of thrust for about 90 sec. It will replace the interim powerplant consisting of two 12,000-lb.-thrust *XLR-11* engines. It will be installed in the *X-15* after current tests with the interim powerplant.

Harrison Storms, chief engineer for North American Aviation, prime for *X-15*, said it may fly with the new powerplant by May 15.

Mercury Antenna Contract Let



THESE ARE one type of antenna Canoga will make for Project *Mercury*.

LOS ANGELES—Canoga Division of Underwood Corp. has received a contract in excess of $1 million for design and manufacture of all antennas for Project *Mercury* ground-based telemetry, communications and command control.

Canoga President George H. Nibbe said first deliveries are tentatively scheduled for midyear. The program calls for some 50 antenna systems. There will be 13 automatic tracking quad-helix antennas to be used for acquisition and tracking of VHF telemetry signals.

Angle data from the tracking antennas can be fed to slaved radars, communications and command antennas and computers. These will provide extrapolations for "down-range" orbital data as well as orbit prediction for subsequent passes.

All steerable antenna systems and radars along the anticipated orbit will be positioned automatically from computer output until the acquisition aid antennas are tracking.

Canoga antennas will track by means of a phase-comparison simultaneous lobing technique. Acquisition aid antennas when not tracking will be slaved to tracking radars and used only for reception of telemetry signals.

Other antennas covered by the contract include quad-helices for the purpose of telemetry and voice communications receiving as well as a third group of command control and voice communications transmitting.

Antennas in the latter group utilize four outboard helices operating in the 200-300 megacycle region for command transmission purposes.

Polarizations of opposite sense for transmitting and receiving helices is used to minimize interference between voice transmitting and receiving antennas at the same location.

RCA Gets $474.8 Million BMEWS Installation Award

Air Force last week announced award of a $474,831,000 contract to Radio Corporation of America for work on the Ballistic Missile Early Warning System (BMEWS). (See special construction report, p. 28.)

The award, according to the Department of Defense, brings total BMEWS investment in the missile warning system to more than $700 million. RCA has been working on the project for more than a year. Remaining work will spread over several more years.

Ultimately the system is expected to cost about $800 million. The first station in Thule, Greenland, is expected to be operating before the end of this year. A second station in Clear, Alaska, is to be completed in 1961.

Missile R&D Far More Costly Than Production

About 60 cents of each missile dollar goes to research and development—thus exceeding production costs of the missile, according to Orval R. Cook, president of the Aerospace Industries Association.

This shows a new trend since war years when money spent for aircraft went predominantly to production. However, in today's intercontinental bomber, R&D amounts to as much as 20%.

Cook noted that employment figures also reflect the emphasis on engineering, tooling and other indirect specialties—over direct production. In 1959, for 30 plants surveyed by the USAF's Air Materiel Command, 65% of the 451,098 workers were engaged in indirect specialties. In 1955, the figure for 469,794 employees in the same plants was 60%. In the peak employment war year of 1943, statistics show that only 20% were engaged in R&D, while 80% were directly in manufacturing.

Hawk kills *Honest John*

SEQUENCE of shots from official Army film shows Raytheon *Hawk* finding and killing Douglas *Honest John* in test over White Sands, N.M., Jan. 29. Army called it first known kill of its kind. First photo shows *Honest John* in flight; second, *Hawk* taking off; third, *Hawk* changes course and dives for kill; fourth, intercept and explosion.

Low-Level Multiplexer Passes Tests

Radiation, Inc. takes big step forward with its Radiplex 89—first true low-level system—which drastically cuts size of equipment; unit design for Minuteman

A significant forward step in telemetry and data acquisition has been taken with successful operation of the first true low-level electronic multiplexer.

The unit—Radiation, Inc.'s Radiplex 89—has been operationally tested at Thiokol's Utah Division static test stands. In parallel tests with conventional units using preamplifiers, the Radiplex exhibited 10-microvolt resolution and provided more accurate data than the comparative system.

Low-level multiplexing has been a much sought-after but elusive goal for many years. Until now, so-called low-level units could handle signals only down to about ten millivolts.

The big advantage of such a system is, of course, the elimination of preamps—with their size, power requirements, and noise problems. The 48-channel Radiplex unit boils down to one single chassis the equipment formerly requiring three 6-foot cabinets.

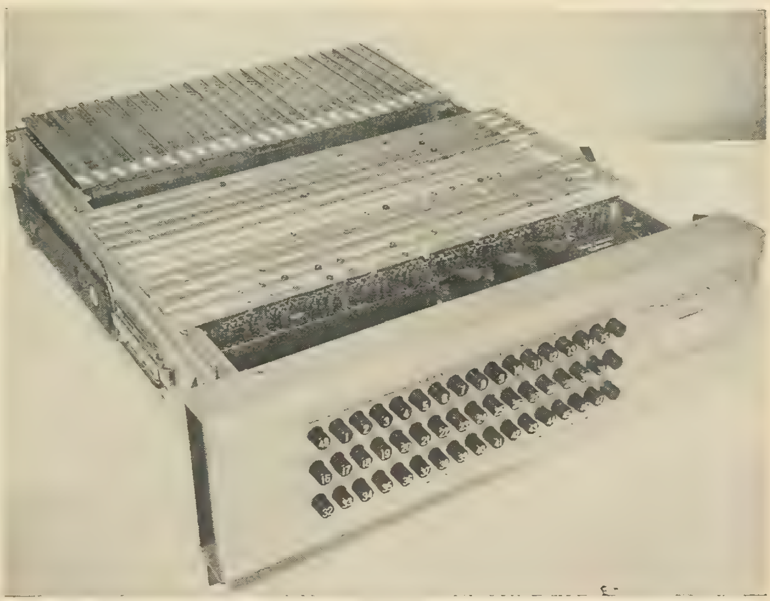
Such a system is particularly desirable in air- and missile-borne instrumentation. It will help solve one of the greatest problems in the use of digital telemetry equipment: size and complexity. One unit is already being designed for use in the *Minuteman* PCM system. Other 96-channel units will be used in airborne installations.

In application, multiplexers are used to continuously sample outputs from strain gages, thermocouples, and other types of transducers. Thus many channels of information may be carried on one data channel. Earliest types were simple electrical switches; electrical commutating discs, switching tubes, and electronic switches have all been used. The biggest problem in the process, however, is the noise generated by the switch itself—noise of sufficiently high level to overcome output signals of relatively low level. In consequence, transducer outputs have had to be preamplified before they were usable; and, as mentioned, preamplification posed its own problems.

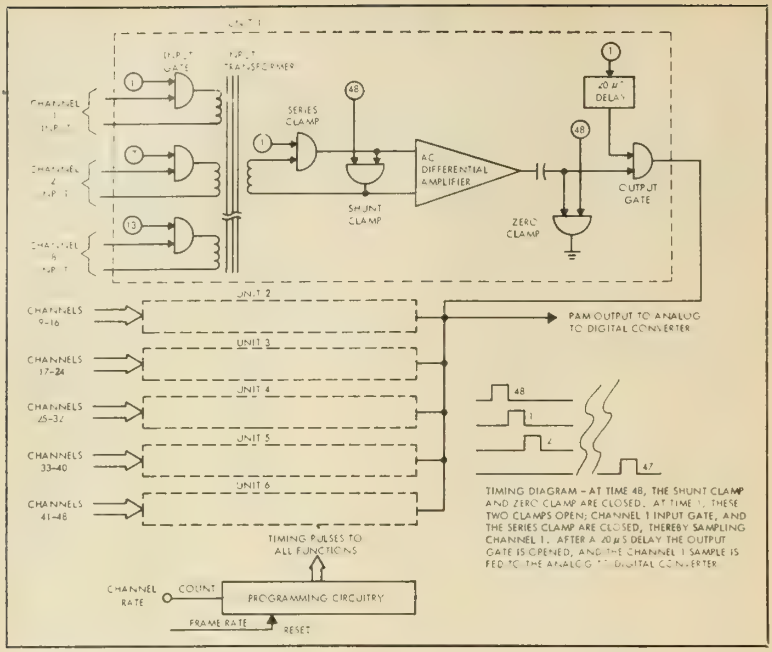
• **Unique features**—Several different developments by Radiation engineers were combined to achieve the resolution, low noise level, freedom from crosstalk and other qualities that make the Radiplex 89 unique.

The first of these is the electronic switches, which use transistors instead of the usual diode gates. The transistors are considerably less noisy in the operating range involved than are diode gates. Second, they permit isolation of the switching impulses from the data itself. Third, they are inherently low-level devices in contrast to the high-level diode switches which have been used in the past.

The second unique feature is the special coupling transformer developed for linking the input switches with the amplifiers, and the way these transformers are used. Six transformers are employed, each one with eight isolated windings, yielding a total capacity of 48 channels. Input signals are rotated among the six transformers so that each one has five-channel intervals for recovery. This provides ample time for all transients to decay to less than 0.1% before that transformer is used again. The isolation of transformer windings, together with placement of the transistor input gates in relation to the input winding, result in common mode rejection of 10^6:1 and crosstalk of less than 0.05%.



MULTIPLEXER is of solid-state construction throughout. All circuits are mounted on plug-in boards. The unit shown combines all the equipment needed to handle 48 channels and replaces that which would otherwise take up three full cabinets.



SIMPLIFIED block diagram of multiplexer shows its unique arrangement for rotating inputs to the six transformers for isolation and recovery.

A third very important development is design of low-level amplifiers and clamping circuits in the inputs and outputs of the amplifiers. These permit zeroing of amplifiers immediately before each signal is applied to the amplifier. This provides compensation for loss of dc reference due to input transformer coupling, and results in linearity in 0.1%.

The output gating also contributes significantly to performance of the Radiplex 89. The same timing pulse used for zero clamping of the low-level amplifiers is used as a timing pulse to these output gates. It delays and shortens readout to insure elimination of spikes which might interfere with coder operation, and delivers a smooth and essentially level output to the coder.

Another useful feature of the low-level Radiplex 89 is its program flexibility. Internally the unit consists of six sections, each with eight-input channel capability. At a 24-word rate, each section is independently driven at a 4000 cps rate. This may be subdivided among the 8 channels in groups of 1, 2, 4 and 8, thereby providing channel sampling rates of 4000, 2000, 1000 and 500 cps, respectively. Additional units may be used in series at equivalently lower sampling rates. Flexibility of programming is accomplished by use of alternate programmer matrix boards.

The Radiplex, while actually designed for operation with the Radicon coder, is compatible with most other coders. If used with the Radicon, pushbutton channel select switches make it possible to view any one of the 48 channels on a digital display.

Tube Market May Be $900-Million This Year

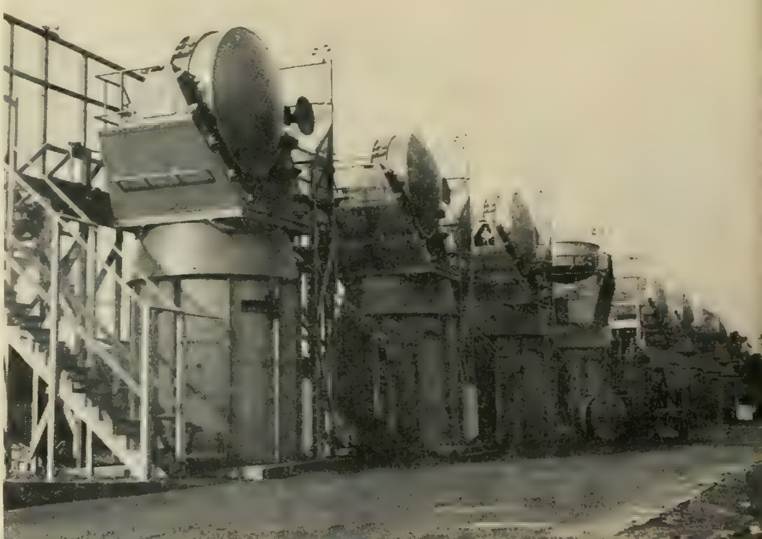
Heavy demands for electron tubes by military and industrial users, and a strong market for home entertainment products, should boost the electronics industry's tube sales to an all-time high of $900 million in 1960.

This is the prediction of Douglas Y. Smith, vice-president and general manager, RCA Electron Tube Division, who said in Newark, N.J., that tubes are finding new uses in the rapidly-expanding electronics industry.

"As an illustration of the tube's importance to the nation's space program," he said, "a single test launching at Cape Canaveral may require as many as 100,000 electron tubes inside the rocket and at ground control stations."

"Factory sales of all types of electron tubes by the industry totaled approximately $870 million in 1959, an increase of nearly 12% over the 1958 level," he pointed out. "Of last year's total, receiving tubes accounted for nearly $370 million, industrial and military tubes represented approximately $250 million, with the balance of about $250 million in TV picture tubes. Greatest expansion was in industrial tube sales which rose about 20% over the 1958 sales levels."

Terrier Radars for Long Beach



THESE AN/SPG-55 radars for *Terrier*, developed by Sperry Gyroscope Co., will be installed on the nuclear-powered USS Long Beach. *Terrier* radar is completely automatic; from the time the target is designated until the radar goes into automatic tracking, the operator's sole function is as an observer. Equipment supplied by Sperry for the Long Beach includes four SPG-55 radars, two SPG-49 *(Talos)* and SPW-2 radars, two Mark III computers, and one WDE system.

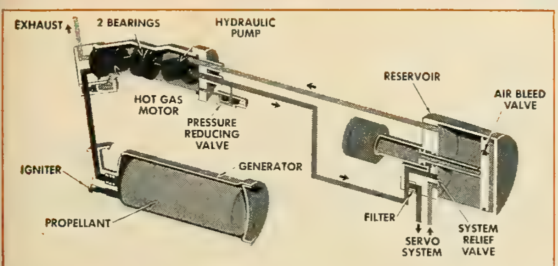
FLIGHT HARDWARE...NOW

VICKERS HOT GAS AUXILIARY POWER SYSTEMS

for missiles and spacecraft

CONCEPT

Vickers piston motors — as used in virtually all existing commercial and military aircraft — are now modified to operate efficiently on propellant-generated hot gas, or bleed gas from the main propulsion system. Minimum weight is achieved by mounting the hot gas motor "shaft-to-shaft" with a Vickers piston hydraulic pump in a common housing. The motorpump, a simple gas generator, hydraulic reservoir, filter, and relief valve are integrally mounted to form a complete Auxiliary Power System in a compact package.



DEVELOPMENT

Production line Vickers hydraulic motors have been operating on hot gas for over 2 years. Units have run on gases as hot as 2300°F without modification.

The present flight hardware was built and tested after an intensive prototype development effort. Test program motorpumps have accumulated over 100 runs each for 1 minute of operation cycle. Since the current development program is aimed at meeting known APS requirements, no limits have been established on the operating cycle duration for this type of equipment.

CONCLUSIONS

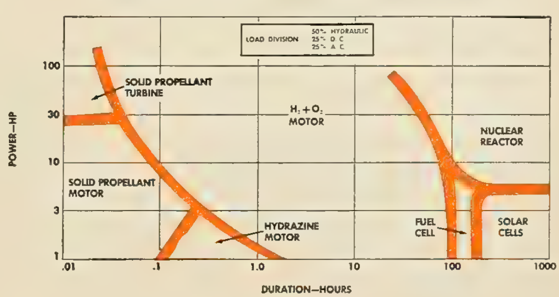
Performance and reliability goals for this concept have been met successfully. A complete hot gas APS package in the 2 - 8 horsepower range, shown above, is available within 90 days. Customer specifications for these and larger systems are invited. Write for Bulletin A-5223B.

APPLICATIONS

Because of the increasing scope of APS applications, Vickers conducted a series of studies to establish criteria for APS selection. Recent study results (published in March, 1959) indicate that for short duration operation, hot gas motors offer the best weight advantage in the 1 to 30 hp range. See curve below.

Attractive reliability and early delivery resulting from extensive use of proven hardware may extend the application of these systems to an even greater range of second and third generation missiles and spacecraft. Additional advantages include: low speed equipment (up to 10,000 rpm), convenient ground checkout, growth potential, and no alert time required.

OPTIMUM WEIGHT NON-PROPULSIVE POWER SYSTEMS



AERO HYDRAULICS DIVISION
VICKERS INCORPORATED
DETROIT 32, MICHIGAN

division of:
SPERRY RAND CORPORATION

8386

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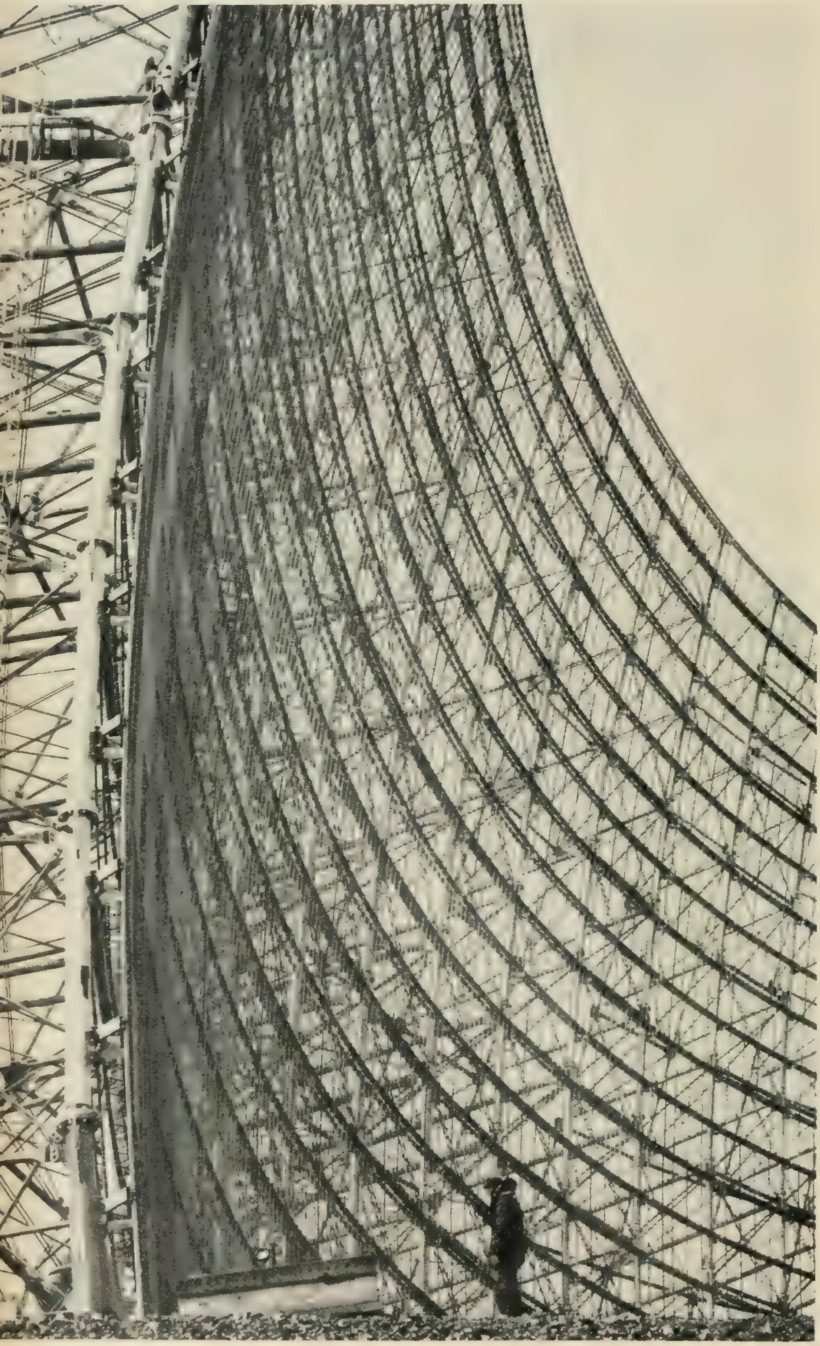
GE Progressing With BMEWS Radar

2000 to 3000-mile-range surveillance system being built under $100-million RCA subcontract



Under a subcontract to Radio Corporation of America, prime for the Air Force Ballistic Missile Early Warning System, General Electric designed and is building and testing the surveillance or detection radar system. Expected to have a range of from 2000-3000 miles, GE's contract for the colossus exceeds $100 million.

The entire BMEWS system includes sites at Thule, Greenland, Clear, Alaska, and another somewhere in Scotland. RCA also has built a test and training site at Moorestown, N.J., for its tracking radar system. It is expected that total cost of BMEWS will approach $1 billion.

Shown here are photographs of some of the equipment and part of the installation at Site 1 in Thule, now under construction.

←

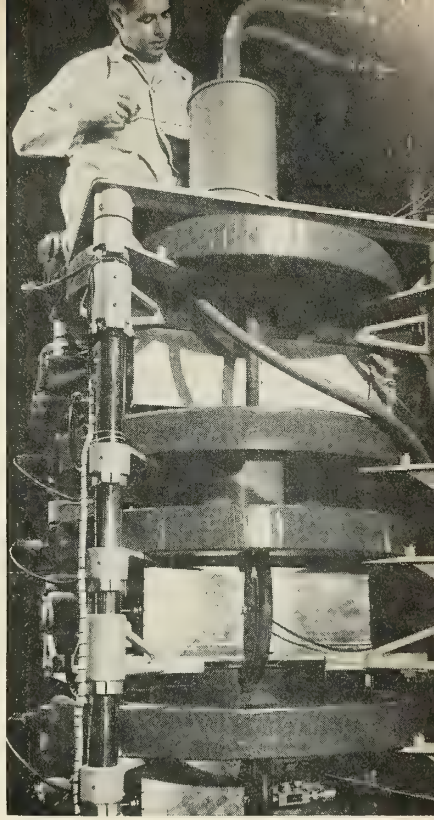
NEW USAF SURVEILLANCE radar antenna at BMEWS Site 1 in Thule dwarfs workman and bulldozer in foreground. Over 160-ft. high, the 12-in. diameter nickel-steel pipe used in its construction never had been manufactured in the U.S. prior to the award of the BMEWS contract. Built to withstand 185-mph winds with up to a 6-in. coating of ice, structure was erected to a 0.75-in. tolerance overall.

→

NEWLY-DESIGNED duplexing filters (foreground) are being tested in Syracuse, N.Y. In the background, is one of the massive scanning-switch assemblies. An unusual high-speed rotary switch, its function is to permit transmission and reception of radar pulses alternately. Cycle is programmed many times per second. The duplexer blocks transmitted energy from the receivers but passes reflected radar pulses to the receivers.

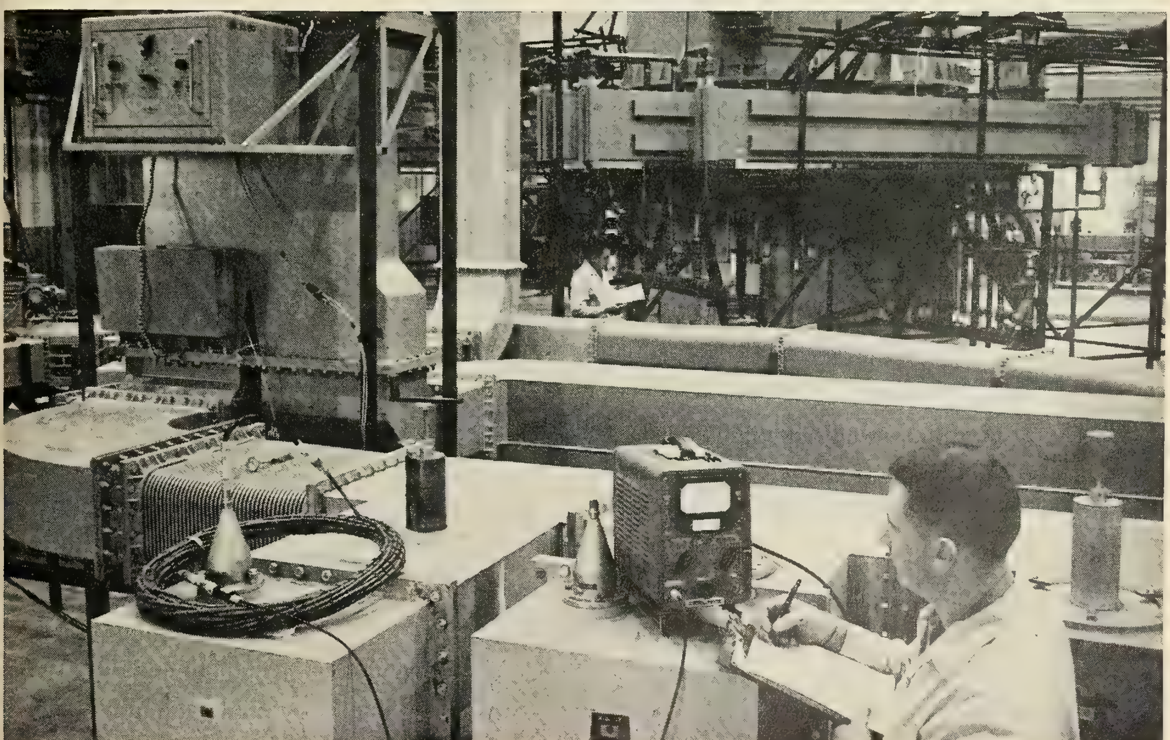
nstallation

GROUPS of these 9-ft. klystron amplifier tubes are used in each of the multi-megawatt-pulse transmitters. Because of the very high power used, over 2000 55-gallon drums of oil are needed for cooling. At the GE test laboratory, a 34,000-volt input is converted to 120,000 volts, dc to operate the system. (Note the man-sized focus coils encircling the klystron.)



BMEWS Surveillance Radar Statistics

Item	Size (each)	Weight Each	Weight Total	No. in use per Site	Manufacturer
AN/FPS-50 Radar Surveillance System	......	......	13,350 tons	1	General Elec.-Heavy Military Electronics Dept.
Transmitters:	......	278 tons	2,221 tons	8	Continental Electronics Mfg.
Cooling oil	......	......	......	111,110 gal.	Eitel-McCullough
Klystrons	9 ft. high	1,600 lbs.	......	......	Varian
Scanning switch assembly	16.5'h x 21' dia.	76,600 lbs.	613,000 lbs.	8	General Bronze Corp.
Antennas:	165'h x 400' lg.	1,500 tons	6,000 tons	4	D. S. Kennedy & Co.
Backstays	3.5' dia. x 60'h	7.5 tons	150 tons	(20/ant.)	
Concrete footings	10,000 cu. yds. total	......	......	160	
Reflector panels	5' x 7' each	......	......	2240/ant.	
Nickel-steel constr. pipe	6" to 12" dia.	......	......	4.5 miles	
Aluminum waveguide	......	......	1,574 tons	21 miles	
Feedhorns	......	......	......	704	
De-icers	3360 BTU/hr.	......	......	16	Carrier Corp.
Elec. Equip. Cabinets	......	......	......	294	
Monitor & Control Consoles	......	......	......	10	
Cable	......	......	175 tons	15,000 pc.	



Speedy Readout

Wide Potential Seen in Data Processing

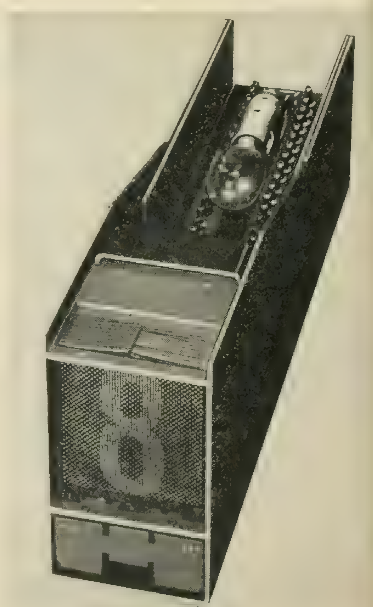
A new simplified high-speed readout display should have wide potential in automatic data processing. Using a technique of light interference, the unit accepts a binary-coded decimal input and displays alpha-numeric characters.

Developed by Industrial Electronics Engineers, Inc., North Hollywood, Calif., the "Slide Plate" has a one-plane in-line presentation, has a memory, and will function with transistorized equipment. In addition, IEE states, the unit is highly reliable and will cost less than $40.

The device accepts any binary-coded decimal or teleprinter code up to six information bits. Translation is performed without the need for auxiliary circuits, and operation is at a change rate of 30-40 readings per second.

Designed to operate on less than 5 milliwatts signal power, the Slide Plate can be connected directly to transistor or vacuum-tube flip-flops. A unique feature of the device, according to IEE, is that it will retain a displayed alpha-numeric character until commanded to accept and display a new signal input. Again, no auxiliary memory or storage equipment is required.

Checkback and verification circuits



SLIDE PLATE readout unit, developed by Industrial Electronics Engineering, employs light interference technique and very low power (5mw) for high-speed display.

are provided to assure that signals have been accepted properly, and permanent output storage is supplied.

Various models will be available providing 10, 16, or 40 characters. For special applications, up to 64 characters can be provided, said IEE.

Method Improves Measuring Of Frequency-Response

Moscow—Soviet scientists K. V. Zakharov and V. K. Svyatoduch report that they have designed a new measuring set for obtaining frequency-response characteristics of nonlinear automatic control systems.

The lack of a satisfactory method for obtaining these measurements had reportedly caused reluctance to use the frequency-response approach for analysis of nonlinear systems. Chief difficulties in designing a measuring set capable of meeting the measuring requirements were experienced in connection with the presence of higher harmonic oscillations which exist in the output of a nonlinear system subjected to a sinusoidal input force. Harmonic-analysis methods are considered cumbersome and too slow, as they require complex calculations and preliminary oscillographic recording of the process under study.

This electronic device is reportedly capable of performing direct harmonic analysis of the output signals of nonlinear servo systems operating with signals in the form of electrical voltages in the 0.25-50-cps range. (*Avtomatika i telemekhanika,* No. 12, 1959, pp. 1679-1686.)

Quality-Control Analyzer Proposed for Testing

Moscow—The Department of the Technology of the Moscow Higher Technical School imeni Bauman has proposed a quality-control analyzer for testing of magnetic amplifiers.

Although there is a trend toward extending the use of magnetic amplifiers, their introduction on a large scale is said to be hindered by poor technology—mainly by inefficient methods of quality control—manually performed, slow and inaccurate.

The measuring circuit can operate either on industrial or on elevated frequencies. Results of measurements, automatically performed, present complete information on performance of the amplifier during testing. Use of the analyzer is anticipated not only for industrial quality control but also in laboratory prototype testing, where this device will be of importance in accelerating experimental work on development of new models. (*Mashinostroyeniye i priborostroyeniye,* No. 2, 1959.

LOX Supply Stirs Industry Debate

Missile/space use generates $100 million business and takes 22% of nation's output. Air Products backs in-house production, Linde for commercial supply

by Jay Holmes

Liquid oxygen, the pale blue super-cold fluid that provides air for most ballistic missiles and big rockets, has generated more than $100 million in business—and a major industry controversy—in less than four years.

Furthermore, the level of missile/-space LOX consumption is expected to rise in the early 1960's despite inroads being made by solid propellants and storable liquids.

Military security regulations and industry's jealous guarding of its secrets make it impossible to obtain a completely authoritative summary of the LOX business. In addition, most LOX is produced at on-site government plants—rather than purchased from commercial suppliers.

An analysis of the figures available and estimates by industry sources indicates that at least 22% of the nation's production of high-purity (99.5-100%) oxygen goes for missile/space use. The bulk of the remainder is consumed by the steel and chemical industries.

Last year, the U.S. Commerce Department reports, 43.5 billion cubic feet of high-purity oxygen was shipped commercially. According to M/R estimates, the military consumed another 11.3 billion cubic feet produced in its own facilities. Some in industry think the chemical industry produced another 10 billion at captive plants; however, Commerce Department officials insist no such large amount could go unreported. Lower-purity oxygen production totaled about 32.5 billion, making a grand total of 92 to 98 billion cubic feet.

In 1960, barring new railroad or steel strikes, Commerce Department officials expect an across-the-board rise of more than 10%, which would bring the grand total to 105 or 110 billion.

• **Rising curve**—Missile/space LOX consumption is expected to soar in the next few years because of the fantastic quantities burned in testing the 1½-mega-pound *Saturn* and *Nova* booster rockets, the recent NASA-ABMA decision to develop liquid hydrogen-LOX upper stages for *Saturn*, continued testing of the *Atlas* and *Titan* ICBM's and the planned construction of at least 18 *Atlas* and *Titan* launching bases.

Each *Atlas* and *Titan* holds more than 55 tons of LOX when fully loaded. The *Saturn* booster alone will hold more than 200 tons.

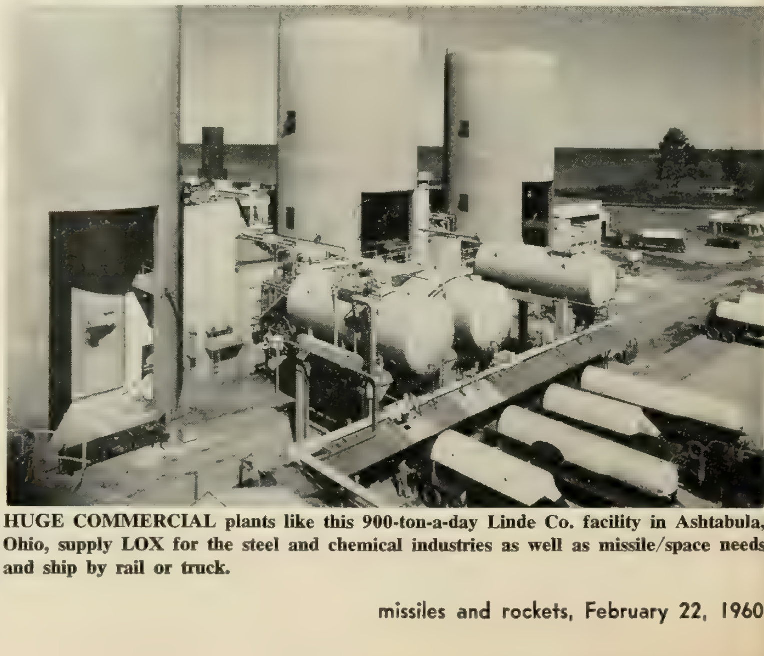
In the steel industry, which devours more than half of the oxygen of all purity grades produced in the United States, oxygen use is on a steeply rising curve because of its rapid spread in open-hearth lancing and the basic oxygen steelmaking process.

• **Procurement controversy**—The great bulk of missile/space LOX is produced on Air Force and Army-owned facilities. In 1959, only about 20% was procured commercially. Some say the government should have obtained much more commercially. Others maintain that present procedures have saved millions of dollars.

Two major companies represent the prevalent opposing philosophies. Air Products Inc., of Allentown, Pa., which has built five major plants and 507 smaller ones for the Air Force and Army since World War II, is the champion of government in-house production. Linde Co. Division of Union Carbide Corp.—the nation's largest producer of industrial gases, with about 50 plants across the nation—has thus far supplied LOX only through commercial channels. However, the company is equipped to build and sell producing plants.

Air Products reported last month that the five largest Air Force plants it built have produced one million tons of liquid oxygen and nitrogen since the first went on stream May 17, 1956. This is the equivalent of 24.2 billion cubic feet. Assuming that nitrogen production was about 10% of the oxygen level, the five plants produced about 22 billion cubic feet of oxygen in less than four years.

Since 1956, Air Products' government revenues for cryogenic liquid pro-

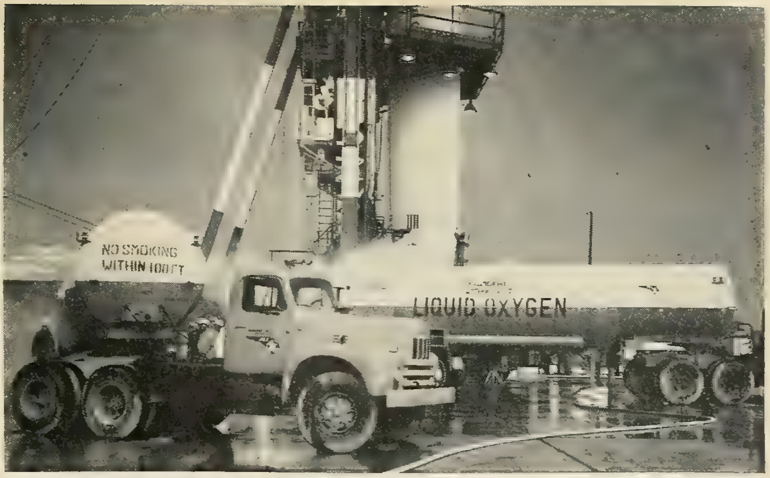


HUGE COMMERCIAL plants like this 900-ton-a-day Linde Co. facility in Ashtabula, Ohio, supply LOX for the steel and chemical industries as well as missile/space needs and ship by rail or truck.

duction and handling equipment have exceeded $95 million, plus another $36 million paid to subcontractors. The overall $131 million, however, includes a classified sum paid for construction and operation of a large liquid hydrogen plant at West Palm Beach, Fla.

For comparison, the Commerce Department reports that 142 billion cubic feet of high-purity oxygen were shipped commercially from 1956 through 1959. Thus, oxygen from the five plants equalled about 15.5% of the nation's commercial production during the four years. The nation's total production of high-purity oxygen over the four years probably was between 190 and 200 billion cubic feet. If so, the five Air Force plants produced between 11 and 11.6% of the total.

Air Products contends that the Air Force saved at least $30 million by building the five plants—at Santa Susana, Nimbus and Edwards AFB, Calif., Denver, and Cape Canaveral. The plants cost $20 million to build, Air Products says, and the operating cost has been $18.5 million—a total of $38.5 million. The Pennsylvania company says the million tons would have cost about $70 million if procured commercially.



TRUCKS DELIVER LOX to missile being readied for launching at Cape Canaveral. Air Force has nearby plant with 165-ton daily capacity. Loaded ICBM swallows more than 55 tons of the cryogenic.

• **Built-in inefficiency?**—Linde spokesmen did not directly dispute the figures cited. However, they noted that prices have historically gone down with increasing volume and that, if very large amounts were procured, prices would drop well below present levels—perhaps as low as $40 a ton.

Linde spokesmen stressed the point that methods of supply must be suited to requirements. If high-capacity plants are built at locations where the demand varies widely, they said, there must be adequate storage facilities and distribution methods to carry off the excess.

In commercial operation, Linde said, variability of demand from individual consumers balances off when one large plant is used as a central source. Development of super insulations has made it possible to ship LOX great distances by rail or truck, according to Linde. This makes it possible to profit from the savings inherent in operating a very large plant.

Air Products said the five installations make 85% of the Air Force's total consumption. The installations' daily capacities are 412.5 tons at Santa Susana, 330 at Nimbus and 165 at the three other locations. Besides these, Air Products has built or is building a classified number of 27.5-ton plants at operational ICBM bases, such as Vandenberg AFB. The Air Products statement was approved by the Air Force.

AIR FORCE PLANT in Santa Susana, Calif., was built and is operated by Air Products Inc. to serve missile/space needs. Most of the plant's 330-ton daily capacity is used by nearby Rocketdyne plant.

• **Air Force buying**—In addition to its in-house production, the Air Force fills some of its needs through commercial procurement. Some of the latter supplies requirements where there are no Air Force plants. Some of it also supplements production of Air Force plants at times of peak demand.

The Air Force procures oxygen through Olmsted AFB, Middletown, Pa., under annual call contracts. Under the contracts, the Air Force does not guarantee purchase of any specific amount, but the purchaser guarantees his selling price. The call contracts for 1959—designated IFB 36-600-59-128—authorized about 95,000 tons production.

The Air Force's Ballistic Missile Division declined to say how much actually was consumed. However, industry sources indicated the figure was about 83,000 tons, about 87.5% of that authorized.

The bid awards, based on the original estimates, totaled $9,674,450. The largest single award of $7,865,000 went to Linde. If actual consumption on the Linde contract followed the reported 87.5% average, its 1959 Air Force business totaled about $6,900,000.

Other awards went to Air Reduction Co. Pacific Division, San Francisco; Victor Equipment Co., San Francisco; Burdett Oxygen Co., Norristown, Pa.; Liquid Carbonic Division, General Dynamics Corp., Chicago; Industrial Air Products, Portland, Ore.; Pacific Oxygen Co., Oakland, Calif.; National Cylinder Gas Division, Chemetron

Corp., Chicago; Air Reduction Sales Co., New York; Dye Oxygen Co., Phoenix, Ariz.; and Sierra Oxygen Co., Reno, Nev.

• **Army arrangements**—The Army, like the Air Force, uses small in-house plants at operational bases. For instance, each *Redstone* battalion is assigned a mobile 5-ton LOX plant manned by Engineers. There are 32 such plants in all. Also, the Army at one time had 11 mobile 20-ton plants and one 50-ton plant. All were developed by the Army Engineers and Air Products and built by Air Products. The 50-ton plant and three of the 20-ton plants have been turned over to the Air Force. Five are in storage and the remaining three at the Engineers' school and research and development center at Ft. Belvoir, Va.

For missile R&D at Redstone Arsenal, the Army has been obtaining its LOX through commercial channels. Linde is a major supplier, but several other companies also have been active. The Army refuses to list its suppliers —their names are classified confidential.

Procurement at Redstone has risen steadily since 1956, although the Army says its needs are decreasing, with most development work completed on its liquid-fueled missiles. *Saturn*, the only major project at Redstone that will use large quantities of LOX, will be transferred to NASA next month.

For the fiscal years 1957-59 and thus far in the current fiscal year, Redstone has consumed 1,550,760,000 cu. ft. of high-purity oxygen, the equivalent of 64,000 tons. Since the Army reported by fiscal years, the exact 1959 total is not available. However, it appears to have been about 39,000 tons.

No estimate is available of the Army's in-house LOX production at mobile plants operated by the Engineers. To arrive at an overall estimate, M/R used a figure of 5000 tons.

• **Fixing the total**—The Air Force did not say how much of the four-year, million-ton total at its five major plants was produced in 1959. However, it must have been about half, since four of the five went on-stream in 1957 and industry sources have said the consumption curve rose steadily. This estimate agrees with the Air Force-approved statement that the plants produced 85% of its requirements, and the industry report that 83,000 tons were procured commercially.

Applying the 10:1 oxygen-nitrogen ratio to 1959 production, the five-plant total would be 455,000 tons of oxygen and 45,000 of nitrogen. Total Air Force 1959 consumption would be 545,000 tons, of which 83,000 tons were procured commercially and 7000 tons at smaller Air Force installations.

This leads to an overall estimate of 589,000 tons consumed by the military for missile/space use, of which 467,000 tons were produced in-house. Recapitulating:

Source	1959 Production (tons)
5 Air Force Plants	455,000
Other Air Force	7,000
Army in-house	5,000
Total military in-house	467,000
Air Force procured	83,000
Army procured	39,000
Total military procured	122,000
Military total	589,000

The military in-house total of 467,000 tons is equivalent to 11.3 billion cubic feet. Adding commercial shipments of 43.5 billion cubic feet and an

LOX-Nitrogen Plants

Location	Capacity (tons per day)	Owner	Operator	Principal Users
Santa Susana, Calif.	412.5	USAF	Air Products Inc.	Rocketdyne
Nimbus, Calif.	330	USAF	Air Products Inc.	Aerojet-General
Pittsburg, Calif.	300	Linde Co.	Linde Co.	Rocket Companies
Denver	165	USAF	Air Products Inc.	Martin Co.
Patrick AFB, Fla.	165	USAF	Air Products Inc.	Cape Canaveral
Edwards AFB, Calif.	165	USAF	Air Products Inc.	Air Force, NASA
Plants under construction (due to be completed in mid-1960)				
Huntsville, Ala.	135	Linde Co.	Linde Co.	Redstone Arsenal and southern region
Neosho, Mo.	135	Linde Co.	Linde Co.	Rocketdyne and Ft. Crowder
Major commercial plants				
East Chicago	900	Linde Co.	Linde Co.	Steel, chemical industries
Ashtabula, Ohio	900	Linde Co.	Linde Co.	Steel, chemical industries
Fontana, Calif.	800	Linde Co.	Linde Co.	Steel, chemical industries
Kitanny, Pa.	700	Linde Co.	Linde Co.	Steel, chemical industries
Essington, Pa.	500	Linde Co.	Linde Co.	Steel, chemical industries
Butler, Pa.	375	Air Reduction Co.	Air Reduction Co.	Steel, chemical industries
Riverton, N.J.	275	Air Reduction Co.	Air Reduction Co.	Steel, chemical industries

Other companies supplying missile/space LOX

Company	Location	Production Capacity (Tons/day)	Estimated 1959 Air Force Sales*
Air Reduction, Pacific Co.	San Francisco	Unavailable	$646,150
Victor Equipment Co.	San Francisco	(4 plants)	$358,500
Burdett Oxygen Co.	Norristown, Pa.	5	$218,500
Liquid Carbonic Div. General Dynamic Corp.	Chicago	Unavailable	$192,300
Industrial Air Products	Portland, Ore.	27.5	$ 86,000
Pacific Ogygen Co.	Oakland, Calif	Unavailable	$ 80,000
National Cylinder Gas Div. Chemetron Corp.	Chicago	(48 plants)	$ 78,000
Air Reduction Co. Sales Co.	New York	(62 plants)	$ 50,000
Dye Oxygen Co.	Phoenix, Ariz.	Unavailable	$ 50,000
Sierra Oxygen Co.	Reno, Nev.	3	$ 50,000
Big Three Welding Supply Co.	Ft. Worth, Tex.	25	

estimated 10 billion cubic feet produced in captive commercial plants brings a grand total of 64.8 billion cubic feet for the nation's total high-purity oxygen production.

Of this, the military total of 589,000 tons represents 14.2 billion cubic feet—or about 22% of the total. If the captive plant production is less than 10 billion cubic feet, as Commerce Department officials insist, then the total is lower and the military share is even higher.

Although total missile/space use of LOX is expected to rise, the share of the overall total may remain static. For the steel and chemical industries also expect to continue the increase in their oxygen consumption in the next few years.

In rockets, LOX-based systems are strong because of the reliability that has developed from experience and because their impulse is close to the highest possible for chemical systems. Hydrogen and fluorine provide the highest impulse and thus—at least theoretically—the b e s t combination. But liquid fluorine costs $5 a pound and produces extremely corrosive products. LOX and hydrogen develop an impulse just 5% less than hydrogen-fluorine and the product is harmless H_2O.

But the biggest argument for oxygen is cost—less than two cents a pound if enough is consumed. And the raw material is abundant everywhere and free—free as the air we breathe.

Another Proposal

Lockheed Outlines Big Solid Motor

Large solid boosters are definitely in the running for space missions from the standpoint of feasibility and technological development.

Giulio Panelli of Lockheed Aircraft Corp's New Design Section told the Institute of Aeronautical Sciences in New York that the big solids compare favorably with similar liquid engines on a system performance basis.

Several vehicles were outlined in the study performed under contract from the National Aeronautics and Space Administration. The Lockheed scientist mentioned specifically:

• A one-million-pound gross weight vehicle designed to place a 40,000-lb. payload in a 300-nautical mile orbit. Twice the length of the *Atlas,* the three-stage bird would have a first stage containing four solid motors, each holding 110,000 lbs. of propellant, generating a total thrust of 3.5 million lbs. The second stage would cluster four LOX-RP-1 188,000 lb. thrust engines. The third stage would be composed of two LOX-liquid hydrogen engines, each having 150,000 lbs. thrust.

• A five-million-pound gross weight vehicle capable of hauling 214,000 lbs. of payload into a 300-nautical mile orbit. The solid first stage would consist of seven motors developing a thrust level of 17.5 million lbs. and carrying 2,191,000 lbs. of fuel. The second stage—containing two LOX, RP-1 engines of 1.5 million lbs. thrust each —and the final stage using ten 150,000-lb.-thrust oxygen-hydrogen engines would complete the vehicle.

• Another 5 million-lb. gross weight vehicle, differing slightly in the propellant weights in the second and third stages but including a fourth stage, could place 79,500 lbs. of payload in a 24-hour equatorial orbit 20,000 nautical miles above the earth.

Panelli said that initial thrust-to-gross-weight ratio was given a great deal of consideration because of its effect on the payload.

Considering the 300-mile orbital missions, the scientist said that payload increases rapidly with an increase in the ratio from about 1.25 to 2.5. The payload increases at a much lower rate up to about a thrust-to-weight ratio of 4, and then begins to decrease.

Panelli showed that maximum payload is obtained when booster weight is about 35% of gross weight. Reduction in payload is gradual until the booster reaches about 65% of total weight; beyond this point, the drop is rapid. The Lockheed designer pointed out that the payload reaches zero before the vehicle is all booster or single stage.

The liquid propellant payload capacities were not calculated as part of the study but were derived from published reports. These sources indicate that in a 300-mile orbital mission the *Saturn* has a capacity from 26,000 to 34,000 lbs. payload in the million-lb. weight category, and the *Nova* has a payload of about 150,000 lbs. in the 5-million-lbs. weight slot, for the same mission.

• **$$ considerations**—Cost comparisons were based on the fact that the cost of a liquid engine is directly proportional to the thrust level while the cost of a solid motor is based on design sophistication and propellant weight. The payload capability of solid boosters is improved because of the increased thrust-to-weight ratio and the consequent gravity loss reduction. Although this effect is the same regardless of the type of booster, the increased thrust level in a solid rocket is not as expensive as that in a liquid rocket because of the cost relationships.

Panelli said that considerations in the mass ratio of missile stages and their resultant effect on payload were also included in the study. He showed that the reduction in payload is small over a large range of mass ratios. This in effect permits changes in staging ratios, within limits, which do not have a great influence on the payload size.

Structural changes of the same magnitudes would have a different effect depending on which stage of the vehicle was involved. These range from least in the first to most in the last—as might be expected. Panelli concluded by remarking that the typical designs described in the solid boosters could be produced by any of the U.S. solid propellant firms within a few years. He added that none of the proposed concepts were to be taken as complete, since cost and logistics would have to be considered along with performance.

Rocketdyne Division of North American Aviation last week disclosed some details on the physical properties of its liquid polybutadiene-based solid propellants.

Rocketdyne has said that polybutadiene-based propellants have physical properties that make them ideal for use in a very large motor, such as the two-megaton space booster under consideration by the Air Force. The company says they have less resistance to tear and less tendency to slump than present-day polyurethane-based propellants.

The data has been confirmed in motor firings up to 10 in. in diameter, Rocketdyne said. See chart below.

Rocketdyne Solid Properties

Rate of Strain (in/in/min)	Temp. (F)	Elongation (%)	Tensile (psi)	Modulus (psi)
0.77	—75	53	568	5900
0.77	170	52	97	350
0.77	75	63	135	510
15.	75	67	190	620
220.	75	69	250	1250

$28 Million in Construction At Cape

Funds going into new test facilities for Mace, Minuteman, Pershing, Centaur, Saturn and Azusa missile tracking network

When President Eisenhower toured the Missile Test Annex recently, he viewed a flurry of building which represented more than $28 million of the defense appropriation. And another $3½ million is going to miscellaneous projects at Patrick AFB and the down-range stations of the Atlantic Missile Range.

Most of the money being poured into the Cape is going to new missile programs. The Air Force *Minuteman* and *Mace*, the Army *Pershing*, the Air Force-NASA *Centaur* and the Army-NASA *Saturn* all are being tested there.

An additional project—to be operational in a few months—is the new Azusa Mark II, an improved missile tracking facility able to measure flight positions up to one-tenth foot at distances up to hundreds of miles down range from its Cape Canaveral site.

First of the four new missile launch facilities to be completed will be the $2,460,000 *Pershing* complex. Buildings in this area include a blockhouse with an eight-foot-thick roof, two launching pads with service towers, a missile installation and checkout building and a helicopter parking apron.

Flight tests of the advanced Air Force *Mace-B* have already been conducted at AFMTC, using conventional launching facilities. However, the 1200-mile-range air breather will get its own "pad"—two reinforced, concrete bomb-proof shelters early this spring.

Construction for the *Minuteman*, second generation Air Force ICBM has cost $6,605,000. In the complex are two igloo-type blockhouses, 50-ft. in diameter with four foot-thick walls. *Minuteman* boasts four launch pads, two ground-level and two silo-type. Completion of the entire area is expected later this year.

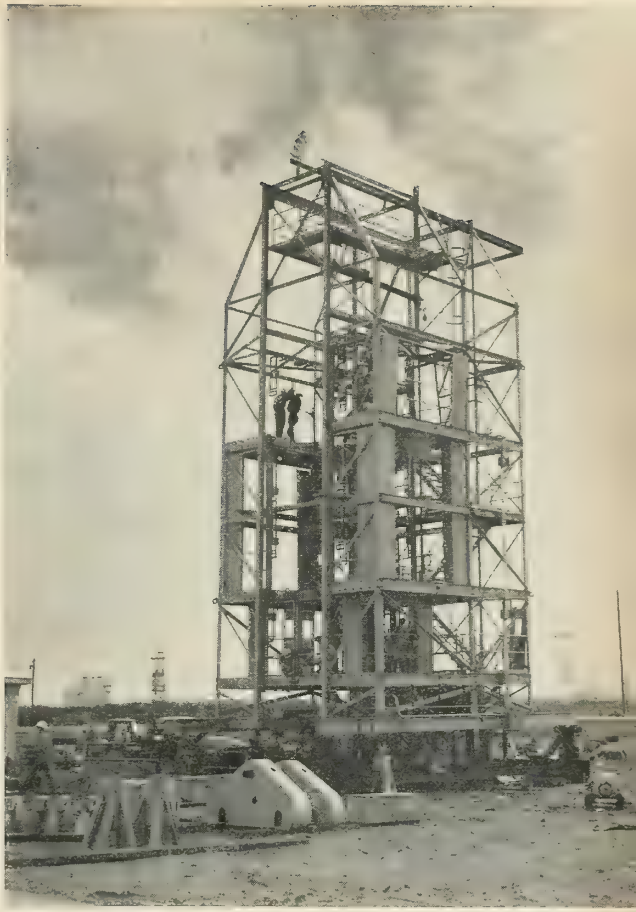
By mid-year a new facility is expected to be in operation. Named the "Space Systems Complex," the group has a *Titan*-type blockhouse, a launch pad and service tower similar to *Atlas* facilities, and a *Titan* and *Saturn*-type blockhouse. The $3,246,000 facility is expected to be used for *Centaur*.

Work on the *Saturn* group is not expected to be finished until early 1961. The Army-NASA project will have a blockhouse, a missile launch pad, a giant 28-story service tower and an umbilical tower.

MINUTEMAN'S two concrete-shell blockhouses, left, will be covered with sandbags for extra protection. Assembly and fuel storage facilities are being built elsewhere on the Cape.

GRANDDADDY of them all, *Saturn* will have the largest service tower on the Cape—rising 305 feet off the ground. Contracts for blockhouse and other facilities total $10 million.

CAPE CANAVERAL MISSILE TEST ANNEX points of interest are: 1) Central Control, 2) Industrial Area, 3) Heavy Ballistic Launch Area, 4) ICBM Launch Area, 5) Original Cape Launch Area, 6) Heavy Ballistic Launch Area (Proposed), 7) IRBM Launch Area, 8) R&D Cruise Launch Area, (Proposed) 9) Training Cruise Launch Area (Proposed), 10) Troop Bivouac Area, 11) Harbor Facilities, 12) Liquid Oxygen Plant, 13) Transmitter Area, 14) Explosive (Fuel) Storage, 15) Receiver Area, 16) Skid Strip.



MISSILE SERVICE TOWERS are the skyline at Cape Canaveral. In the foreground is one of two *Pershing* facilities, while *Thor, Jupiter,* and *Redstone* dot the background.

TEN ANTENNAS and necessary support equipment comprise the new Azusa Mark II tracking system built for the Air Force by Convair. The system can detect flight positions of up to one-tenth foot.

HARD SITE LAUNCHER for AF *Mace* is one of two prototype operational models. The tubes at the rear of the launchers are flame deflectors.

Fatigue Life of Bolts Upped

The fatigue life of bolts can be increased from four to twelve times their present endurance through a new development in nuts by the Elastic Stop Nut Corp. of Union, N.J.

The new concept Double/Durability nuts, has been under study by North American, Lockheed's Missile and Space Division, Chance Vought and Rocketdyne for possible incorporation into existing missile and airframe designs and future vehicles.

Engineers at ESN found that the fatigue failure of a threaded connection usually occurs at the first fully engaged thread of the bolt and seldom in the nut body because it is loaded in relatively pure compression. Although there is stress at all points of engagement of the nut and bolt threads, the greatest is on the first fully engaged thread above the nut base.

ESN EQUA-STRESS thread form (right) shows redistribution of stresses when compared to standard nut (left). (A) is the wide base thread change, and (B) illustrates the bottom countersink.

The new nut embodies two changes —flexible lower nut threads and a special, small-angle bottom countersink. The effect of these innovations is tc redistribute the load over a greater portion of the nut, increasing the fatigue life of the bolt.

• **Reducing bases**—Flexibility is obtained by reducing the bases of each of the threads in the lower part of the nut. Then these threads deflect a greater amount, redistributing the load so that a smaller part of it is transmitted to the bolt by the lower nut threads. Since maximum pressure on a thread is carried near the pitch diameter and the new thread has a standard pitch diameter, the load is carried in the same radial location.

The special countersink increases the minor diameter of the lower nut threads. This truncation provides a gradual effective increase in pitch of the nut threads to accommodate the growth in pitch which occurs in the bolt threads.

In applying this to a full line of nuts, modifications must be determined individually for the specific thread size and related to the sizes, thread heights, hardness and external configurations.

In existing designs, the new bolt will increase reliability and reduce maintenance time—new designs can depend on smaller connections or fewer large ones, with resultant savings in space and weight.

Armour Friction Studies Include Single Crystals

The high temperature seal and bearing qualities of synthetic sapphires are being investigated by the Armour Research Foundation of the University of Illinois under an Air Force Air Research and Development Command contract.

Quartz, titanium dioxide, spinel and boron carbide are the other inorganic single crystal materials up for evaluation. The single crystal types were chosen because they present the best available surfaces for the friction studies which are the basis of the program.

A device which measures the frictional force encountered by the passage of a slider over the material to be tested at temperatures up to 4000°F was developed for the studies. Surface damage caused by friction and wear is observed in several ways, including optical and electron microscopy.

Under the direction of senior scientist Charles Riesz, the investigation will determine how speed, surface roughness, hardness, and crystal orientation influence the specific mechanism of friction and wear in single crystals of inorganic non-metallic materials.

Corning Makes Glass for *Mercury* Capsule Viewports

The first astronaut will do his sightseeing through four panes of polished, high-temperature glass.

The rectangular panels are being produced by Corning Glass for McDonnell Aircraft, builder of the *Mercury* capsule.

The viewports will consist of two outer panels of 96% silica glass separated by a heat-retarding air space from two inner panels of heat-resistant aluminosilicate glass. The window is designed to withstand re-entry temperatures and remain watertight in an ocean landing.

Observations taken by the pilot through the port will help in determining the vehicle's attitude and the optical quality of the glass will permit astronomical photographs.

New Resin May Be Used As Solid Propellant Binder

A new line of epoxy resins with a possible role as solid propellant binders has been announced by Food Machinery and Chemical Corp.

Basically epoxidized polyolefins, the resins are in many potentially reactive groups located internally and externally along the hydrocarbon chain. Designated "Oxiron," they are polyfunctional, exhibiting curing versatility through multiple epoxy and hydroxy groups—and through double bonds.

The resins are stable at elevated temperatures, retaining their electrical properties.

Beryllium Oxide Output Tripled in Plant Expansion

Production of beryllium oxide ceramic materials at National Beryllia Corp. will be tripled with completion of expanded facilities at the firm's Haskell, N.J., plant.

Conventional hot and cold pressing methods, new extrusion and slip-casting techniques and specially-equipped machine tools are part of the expansion program.

Basic and applied research facilities were also increased. C. E. Nelson, President, said that beryllium oxide fibers and foam, metal-ceramic combinations and methods for production of larger beryllia shapes than currently possible, are projects being investigated in the laboratories.

The machine shop is equipped to avoid the toxic dust problems associated with the working of beryllium oxides, and parts can be formed to customer specifications before delivery.

Beryllium Welding Studied by British Agency

Various methods of joining crack-sensitive beryllium have been under study by the Beryllium Section of the British Atomic Weapons Research Establishment, Aldermaston, Berkshire.

Conditions in the satisfactory production of fusion welds were determined although butt welding of beryllium sheets still presents problems.

European Missile Market Wide Open

But good products and selling know-how are must—U.S. companies show preference for Geneva sales offices, with Paris second

by Anthony Vandyk

GENEVA, SWITZERLAND—With Europe now enjoying a prosperity never before known and currency restrictions on their way out, prospects have never been so bright for the U.S. missile salesman with a good product and good selling know-how.

The European missile market is wide open. The few European missiles that have reached the production stage are relatively simple ones. There is increasing realization that Europe cannot afford to parallel the U.S. missile program and that the most logical course is either to buy U.S.-manufactured missiles or build them under license.

But how can you penetrate the market? Basically there are two ways: Set up your own office in Europe and have your sales force operate from there—or have your salesmen based at the head office in the United States. Although the jet age has made commuting across the Atlantic much easier than it used to be, more and more companies are showing a preference to have their own set-up in Europe.

(There is a third method of selling in Europe—to operate through a European agent; but few U.S. missile manufacturers have found this method satisfactory.)

• **Geneva HQ**—Geneva has been chosen as the location for the European offices of most U.S. aircraft and missile manufacturers. Among the companies located here are Boeing, Convair, Douglas, General Electric, Grumman, Lockheed, North American and RCA.

Situated almost in the center of Western Europe and endowed with good communications, Geneva also offers a favorable company tax situation, a stable currency and a working climate more like that of the U.S. than anything else in Europe. Geneva's main disadvantage at present is an acute housing shortage.

• **Paris for contacts**—Second choice as a European office location is Paris. Lockheed recently decided to make Paris its main European headquarters, although it will retain its Geneva office.

Other companies that have chosen Paris include Aerojet-General, Chance Vought, Hughes, Northrop and Republic Aviation. The main advantage of Paris is that the North Atlantic Treaty Organization (NATO) and the Supreme Headquarters Allied Powers in Europe (SHAPE) are located there.

Although life has become a little easier in Paris in recent years, there is still a shortage of office space and housing. Such factors as the old-fashioned telephone system, the lack of taxis at certain times of day, and the tendency of certain vital services to go on strike do not make life too easy for the American businessmen based in the French capital.

Just how important contacts with the headquarters of NATO and SHAPE are for the purpose of doing business in Europe is a moot point. Certainly, officials in NATO's Division of Production and Logistics are extremely well informed on all the weapons and production facilities of the West.

At SHAPE headquarters just outside Paris, briefings can be obtained on overall European military requirements. And at the NATO Maintenance Supply Services Agency (NAMSSA) at Boulogne/Billancourt in the suburbs of Paris, information can be obtained on what equipment is being purchased on a joint basis by the NATO nations. The NATO Advisory Group on Aeronautical Research and Development (AGARD) can also supply useful information.

• **Washington briefings**—Some of the information obtainable from NATO and SHAPE in Paris can also be obtained in Washington. In fact, before a company sends a salesman to Europe he should first visit Washington. Most Washington representatives are able to tell Europe-bound salesmen where to get background information. The military attachés in the embassies of the nations where the sales efforts is to be made are also key men to be seen. Some of the larger nations have military procurement missions in Washington, and these are sometimes more knowledgeable than the attachés.

Introductions to the U.S. attachés in the European countries to be visited can be arranged through the Pentagon, the Commerce Department and the State Department. In certain countries the salesman may find the U.S. Military Aid Advisory Groups (MAAG) a more fruitful source of information than the attachés, but contact should be made with the attaché.

The commercial staffs of U.S. embassies in Europe can often give useful background on foreign companies which might be interested in concluding license agreements. The Export Service of the Aerospace Industries Association in Washington can also be helpful.

• **Observing formalities**—Before leaving for Europe the salesman is advised to set up as many appointments as possible by correspondence. Getting in to see European officials without an appointment is extremely difficult; trying to contact them by phone is almost impossible.

If there is no opportunity to make the appointment until the salesman arrives on the spot, an embassy official should be asked to make an introductory phone call. He is more likely to find the European official "in" than is the salesman. However, embassy officials cannot be expected to do more than pave the way; once the salesman has been put in contact with the European he wants to meet he is obviously on his own.

In general, the European government official or military officer is on the formal side and does not respond favorably to being addressed on a first-name basis until the contact is really close. It is difficult to get to know these people very quickly; and the salesman must adjust his tempo to that of his potential customers.

He should not be surprised to find that his first invitation to take European officials out to a meal—or even to buy them a drink—will be courteously refused. Business has to be done in the office and premature offers of hospitality may be greeted with suspicion.

The same applies to give-aways, although after a short acquaintanceship

most European government officials—and particularly military officers—will be glad to accept a missile or an aircraft model "for my son." Dealing with European businessmen is a little easier. There is generally less formality, and more willingness to discuss things, in a restaurant than in an office.

• **On-the-spot selling**—Most experienced U.S. salesmen operating in Europe agree that while contacts with NATO and SHAPE headquarters in Paris may be valuable for background, the actual selling job has to be done in the country concerned. The military staffs in the capitals of the various countries still call the shots on national requirements while civilian officials usually hold the pursestrings.

A major factor in selling to the European nations is of course the U.S. "give-away" program. No European nation wants to buy something that it could get for free. And many would prefer to get an inferior article for free than pay for something better. The Pentagon can give the salesman the best briefing on what materiel is likely to be made available to European nations under the grant-aid program. And it should also be able to indicate whether this program is to involve the procurement of European missiles for the NATO nations.

Let's say it again: the European missile market is wide open. The prospects have never been so bright. All it takes is salesmanship.

British Satellite to Make 6 Ionospheric Experiments

by G. V. E. Thompson

LONDON—Work has started on the construction of British equipment to be carried in the first Anglo-American satellite. This will be launched in a U.S.-built *Scout* vehicle from a site on the East Coast of the U.S. towards the end of 1961.

The proposed orbit will carry the satellite over the British Isles and it will be visible as far north as Edinburgh. The altitude would vary between 200 and 600 miles and a lifetime of at least six months is expected.

NASA and a British National Committee on Space Research delegation discussed the project in Washington recently and agreed on a program. The first satellite will carry apparatus for six scientific experiments in the ionosphere. This part of the payload will weigh about 20 lb. and the rest of the satellite (telemetry, structure and solar power units) will be American-built and weigh around 100 lb.

• **University College experiments**—The head of the British Committee is Professor H. S. W. Massey, of University College, London. For several years he and his colleagues in the Physics Department have been studying ionized gases, and plan two experiments embodying the techniques they have developed.

The first will use a small sperical probe to measure the temperature of the electrons in the ionosphere. The probe will be mounted flush with the skin of the satellite and will be associated with electronic means for studying the current/voltage curve. This system is insensitive to changes in satellite potential and to photoelectric currents.

The second ionization study is intended to yield information about the variation in the nature of the positive ions with time of day, latitude and season. The ion energy spectrum is measured, and because the speed of the satellite is large in comparison with the mean random speed of the ions, their mass spectrum is easily obtained. For this experiment, another spherical probe is used, fitted with a 4-in. diam. screen charged to repel electrons.

Being spherical, the probe is insensitive to satellite orientation; it is also mounted on the spin axis of the satellite, so that it does not wander in and out of its wake.

Two other experiments are being contributed by Prof. Massey's group. The flux of Lyman-alpha radiation will be measured by an ionization chamber with a lithium fluoride window and filled with nitric oxide; soft X-rays will be recorded by proportional counters feeding an automatic analysis system.

• **Birmingham University studies**—The fifth instrument to be installed in the *Scout* satellite will measure the free electron population density in space and the electrostatic potential of the satellite vehicle relative to its space environment. Provided by the Electron Physics Department of the University of Birmingham, it consists of a subminiature electronics package which provides a 10 mc/s source frequency and a slowly varying bias voltage to two sensing electrodes, each a few square inches in area and a few inches apart. Transistors are used throughout and electron populations down to a few thousand per cubic centimetre can be measured, so that the instrument should prove suitable for use also in satellites with highly eccentric orbits and in orbits and in deep space probes.

• **Cosmic ray counter**—The other experiment to be made with the first Anglo-American satellite has been devised by a group at Imperial College, London, led by Dr. H. Elliot. It will count the nuclei of carbon and heavier elements arriving at the earth and thus yield information about cosmic radiation that is not confused by the protons of the Van Allen radiation belts.

As in the case of the other experiments, this equipment will be tested in rocket firings at Woomera before installation in the satellite. It will also be flown in aircraft and high-altitude balloons when the satellite is in orbit, to obtain complementary data.

• **Other *Scout* firings**—Two other Anglo-American satellites are scheduled at present. The second (in 1962) will make radio-astronomical and meteorological observations. The third is to be held in reserve, but will be launched in 1963 if all goes well.

The data collected from all radio stations will be sent to Britain for analysis, though some might be distributed elsewhere if found too much to handle. Some of the experiments are similar to those carried out by American and Russian scientists, but use of different techniques will make cross-checks possible.

Japanese to Purchase *Tartar* Missiles from U.S.

TOKYO—The Japanese Government is expected shortly to order 42 *Tartar* guided missiles from the United States, along with two launchers and a firing command device which will be installed on a new Japanese Maritime Self-Defense Force destroyer.

Construction work on the 2600-ton destroyer will be started in the near future.

Informed sources report that agreement on the *Tartar* purchase has been reached between the Japanese Defense Agency and the U.S. Defense Department. The U.S. Government reportedly has agreed to shoulder half of the expected $11,857,500 bill.

Russians Stall U.S. Bid for U.N. Talks on Space Uses

The Soviet Union again applied delaying tactics to a United States plea to begin United Nations committee talks on peaceful uses of outer space.

Arkady A. Sobolov, Soviet permanent delegate to the UN, informed the U.S. deputy representative that Russia

felt that the Committee's work should not begin until the latter part of March. On January 5, the United States called for a meeting in January, or at the latest early February. No explanation was offered for the Soviet delay in answering.

Another U.S. suggestion—to hold an international scientific conference for the exchange of outer space information in Geneva during the first two weeks of this September—apparently was not mentioned by Sobolov. U.S. officials had voiced hope that the UN Committee work would get underway as soon as possible, since considerable groundwork will be necessary for the proposed Geneva conference. The 1960 session of the United Nations begins Sept. 20.

British Society Plans Two Symposia This Year

LONDON—The British Interplanetary Society is planning a symposium on rocket and satellite instrumentation to be held on Sept. 1, to be followed by a space navigation symposium towards the end of the year, a society officer recently disclosed.

In April of 1961, the Society plans to hold an European Programme on Space Technology, with a week or 10-day exhibition on astronautics.

New films on Soviet space research were shown at the Feb. 10 meeting of the Society by Professor Masevich, vice president of the Astronomical Council of the USSR Academy of Sciences, and professor of Astrophysics at Moscow University.

French Astronautics Group Adds Members, Activities

by an M/R Correspondent

PARIS—The French Society of Astronautics is undertaking a study of a circumlunar trajectory for a three-man space ship, it was disclosed at the Annual General Assembly here recently.

The navigation committee of the Society, conducting the research, will work extensively with electronic computers.

Other standing committees of the Society are: propulsion, structural materials, space physics, aerothermodynamics, electronics, biology, and legal space matters.

Membership of the fast-growing group has jumped from 221 members in 1958 to 541 in 1959. It plans to take an increasingly large role in the International Astronautical Congress to be held in Stockholm this August.

The French Society also announced that it has obtained office and conference premises for a Paris headquarters of the IAF and its Academy.

Other work of the society includes operation of a French Center for Aero- and Astronautics Medicine, and assistance to young engineers. A series of 18 lectures and help in organizing laboratories is provided for young astronautics fans.

U.S., Japanese to Discuss Joint Space Research Work

TOKYO—Three Japanese scientists will visit the United States within the next few weeks to pave the way for future cooperation between the two countries in Japanese space development. The trio will be here at NASA's invitation.

Groundwork toward a cooperative arrangement was laid in 1959 when the director of the Japanese Science and Technology Agency proposed to NASA that the two countries cooperate in outer space research. Japanese Prime Minister Kishi put forward a similar request when he visited in January.

Secretary of State Christian Herter promised after the Prime Minister's visit that the U.S. would cooperate with Japan in some scientific and outer space projects aimed at gathering information on weather and other non-military problems.

Some Japanese scientists have complained, however, that negotiations conducted between the two countries up to now have indicated that the U.S. is not as "positively interested" in the joint research as Japan had originally expected.

Chemical-Contracting Group Formed by British Firms

LONDON—Formation of the first United Kingdom consortium of chemical producers and contracting firms has been announced. Its members are Constructors John Brown Ltd. (CJB), Boots Pure Drug Co. Ltd., Murgatroyd's Salt & Chemical Co. and Whiffen & Sons Ltd.

This latest combination follows the development during the last few years of consortia of British engineering firms to handle large nuclear energy projects, and the more recent amalgamation of missile/aircraft companies.

The consortium will handle overseas projects, and CJB have already quoted for supplying 10 plants to Russia. CJB will handle the plant construction, and the three chemical companies will provide the process know-how.

Whiffen's are the main producers of hydrazine and its derivatives in Britain.

Other chemical consortia are likely to follow. This type of grouping can compete on good terms with large foreign organizations, at the same time enabling its constituent firms to retain their individuality and avoiding the formation of monopolies or trusts.

Tokyo University Rocket Set For March Testing

TOKYO—The Tokyo University's Industrial Technology Institute is expected to launch its first *Kappa* rocket of 1960 during the latter part of March.

The two-stage *Kappa 8D* rocket test will be conducted on Michikawa Beach, Akita Prefecture, under the direction of a Tokyo University Professor.

The launching is designed to test only the first stage of the two-stage rocket. The 10.12-meter-long rocket, weighing 1.2 tons, is expected to reach an altitude of 25 kilometers before falling into the Japan Sea about 40 kilometers from the beach.

If the initial test proves successful, a new type of *Kappa* rocket capable of reaching an altitude of 100 kilometers will be tested.

Radio Telescope Built For CM-, MM-Wave Ranges

MOSCOW—The Physical Institute imeni P. N. Lebedev, USSR Academy of Sciences, has assembled a new radio telescope for radio-astronomical observations in the cm- and mm-wave ranges.

Designed by P. D. Kalachev and A. Ye. Salomonovich, the antenna of the telescope is a parabolic, sheet-metal reflector 22 mm in diameter with a focal length of 9.5 m. The reflector is rotated by servomotors according to a preset program; it can also be used for automatic tracking of a point in space. An optical telescope is incorporated for sighting and tracking purposes in clear weather.

The control of the radio telescope is centralized in a dispatcher cabin mounted directly on the rotating platform; the cabin also houses recorders and other equipment. The h-f units of the receivers, however, are mounted close to the focus of the paraboloid. Experimental observations carried out since May, 1959, reportedly show that the precision with which the telescope is manufactured meets design requirements for a directional pattern (on a 3.2 cm wavelength) of about six angular minutes at the half-power points. Preliminary evaluation of directional properties on an 8mm wavelength showed a pattern of no more than two angular minutes. *(Radio-teckhnika i elektronika,* No. 12, 1959, p.p. 2-92,-2093.)

'Smallest' Transmission Unit Produced

The world's smallest transmission unit—only one-half inch in diameter—has been designed and produced by Bowmar Instrument Corporation.

Developed to meet the minimum space-weight requirements of electro-mechanical systems in satellites two or three years hence, the tiny "size five" gearhead and speed reducer unit weighs only a few grams and measures ¾ in. in length, the company said.

Bowmar officials added that the unit, designed to increase or decrease the speed of servo-motors, is only two-thirds the size of the "size eight" unit, formerly the tiniest in this field of precision miniature parts. It is capable of producing step-up or step-down ratios of from 10:1 to 2025:1, they said.

Circle No. 225 on Subscriber Service Card

Hypersonic Nozzle

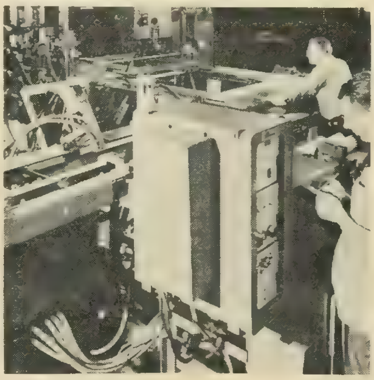
A hypersonic nozzle developed and manufactured by the Electronics Division of the Gorham Manufacturing Company has been credited with a vital role in achieving wind tunnel velocities of more than Mach 7 (5300 mph) in the wind tunnel of the Naval Supersonic Laboratory at the Massachusetts Institute of Technology. These hypersonic speeds, which double the velocities previously achieved in the tunnel, were made possible by placing the Gorham nozzle, which looks something like a giant cigar holder, into an existing lower-speed supersonic tunnel.

Circle No. 226 on Subscriber Service Card.

Electronic Welding Control

An electronic spotwelding control, known as the "Monautronic V-2 Feedback Spotwelding Control," that utilizes digital and analog computer elements, is now being manufactured on a production basis by The Budd Company.

Employing the feedback principle, the Monautronic V-2 unit produces quality welds regardless of actual in-process variables that may produce poor welds even with the best conventional controls.



Among the types of weld variables compensated for by the new Budd control are: line voltage fluctuations, changes in amount of applied electrode force, electrode wear, variations in surface finish, fitup, thickness or hardness of material; variations in amount of ferrous material in secondary circuit, contamination of metal surfaces, variations in horn and electrode lengths causing reactance changes, and proximity of other welds.

Circle No. 227 on Subscriber Service Card.

Adhesive System Bonds 'Non-Bondable' Teflon

A new adhesive system has been developed for bonding "non-bondable" Teflon to itself and to other materials.

Designated PA-746 by the manufacturer, Plastic Associates, the new adhesive system is supplied in kit form for both laboratory and production-line applications. Each kit includes a treating agent which prepares the Teflon surface, plus a two-part bonding agent that cures in a few hours to form a high-strength adhesive joint.

Circle No. 228 on Subscriber Service Card.

Silver Zinc Battery

A new, ultra-compact, automatically activated silver-zinc battery provides one ampere-hour of 28-volt current for missiles where reliable auxiliary power and space requirements are critical.

The Cook Battery's Model P63A weighs 4.2 pounds and is only 2.75" x 5.5" x 5" in size. The battery contains 19 cells, which are of a special foil plate construction to reduce anode gassing and to provide maximum reliability and freedom from short circuits.

The battery provides 6 ampere current with a maximum current of 15 amperes. Discharge time is 10 minutes.

Circle No. 229 on Subscriber Service Card.

Curing Agent Aids RTV Silicone Rubber

The preparation of RTV (room temperature vulcanizing) silicone rubber is now improved and simplified with introduction of three new paste-type curing agents by General Electric's Silicone Products Department.

RTV liquid silicone rubber, used in sealing, potting and encapsulating applications, cures at room temperature after the addition of a curing agent.

These new paste curing agents,

dentified as RTV-992, -993, and -994, implify and improve the processing of ℞TV compounds in several ways. By iluting the liquid curing agent into paste, a greater quantity is required o effect a cure. As a result, it is much asier to accurately weigh and measure he catalyst.

Circle No. 230 on Subscriber Service Card.

Midget Bead Thermistor

A newly developed midget bead hermistor, used in electronics equipment for measuring temperature on he inside and outside surfaces of the *Polaris* and *Atlas* missiles, is so small hat it easily passes through the eye of n ordinary needle.

The bead thermistor is .010 in. in liameter and is mounted on a wire 001 in. in diameter. One pound of hese tiny instruments, manufactured by Gulton Industries, Inc., would have a value of $1,000,000.

Made of manganese nickel oxide, he thermistors can be used inside a hypodermic needle to measure blood

emperature. They are also used in radio frequency power measurements n the microwave field and in the measurement of low gas pressures. They can measure temperatures ranging from −76°F to 572°F.

The tiny devices must be packaged in three separate containers, with careful instructions on each container explaining proper handling procedures. Unless utmost care is exercised, the thermistor could easily be lost before it is used.

High-powered microscopes must be used in constructing the bead thermistors, which are almost invisible to the naked eye.

Circle No. 231 on Subscriber Service Card.

Exploding Bridgewire

An Exploding Bridgewire System (EBW) offers a new concept for safety and reliability in missile ordnance systems. The new EBW System performs rocket motor initiation, missile stage separation, thrust termination, missile destruct upon command and other ordnance functions. A wide range of configurations make the EBW System a direct replacement for conventional detonation systems and provide unequalled safety and reliability along with weight and space savings in multi-stage vehicles.

The EBW System reduces the total weight and design complexity normally required in missile systems by eliminating the need for elaborate electromechanical safing mechanisms.

Circle No. 232 on Subscriber Service Card.

Precision Arc Welder

A new shielded-arc welder designed for precision welding applications is now available from the Vacuum Tube Products division of Hughes Aircraft Company.

The welder, designated the VTW-14, may be used with any of the inert-gas, shielded-arc welding heads now available. It can be used either manually or in automatic machines to precision weld thin metal parts such as metal bellows, stainless steel tubing, electron tube components, or instrument parts. The welder will handle both ferrous and non-ferrous alloys from approximately .001 to .025 inches in thickness and is designed to operate on a continuous production-line basis, Sutherland said.

Circle No. 233 on Subscriber Service Card.

New Molykote Lubricant

A new molybdenum disulfide lubricant, Molykote M-55-Plus, for extreme pressure applications—on drills, taps, cold metal forming dies, punches, etc.—is announced by The Alpha-Molykote Corporation. It supersedes M-55, the 5% EP dispersion in medium oil, and outperforms its predecessor by 116% in welding-load tests and 71% in wear resistance tests.

Circle No. 234 on Subscriber Service Card.

28 Channel Recorder

A magnetic tape loop recorder-reproducer capable of handling up to 28 channels in receiving and recording analog computer data has been developed by Telectro Industries Corp.

In describing the versatile unit, Stanley Rosenberg, board chairman, said that it is fully automatic and reproduces data at speeds from 1 in./sec. to 60 in./sec., with speeds controlled by one knob on the front panel, thus eliminating the need for belt or pulley changes.

Little or no maintenance is required for the precision recording heads which are of long-wearing, self-cleaning con-

struction. They do not require demagnetization after prolonged use, and head gaps are aligned to within 100 micro-inches gap scatter and ± one min. of correct azimuth.

The tape loop runs vertically on the tape transport and on a specially-designed series of rollers and positioning guides to assure correct alignment at all times. Loops can be of any length from 2 to 75 ft., and arrangements can be made to accommodate other lengths. Standard units are available for tapes ¼, ½ and 1 in. wide.

Circle No. 235 on Subscriber Service Card.

Corrosion Measurer

A corrosion measurement probe which checks electrical resistance has been produced by Thompson Ramo Wooldridge Inc. The probe will be manufactured and marketed by the Crest Instrument Division of TRW's subsidiary, Magna Products Inc.

Main use of the new probe will be in measuring hard-to-detect liquid and gaseous contaminants. It can detect the slightest change in humidity, ozone concentration, water content in a non-aqueous liquid, or other environmental conditions which have a tendency to attack metal.

The essential element of the probe is a vacuum-deposited film of metal, 2 to 50 millionths of an inch thick. The metal varies with the application, but usually is one which is readily attacked by the compound being measured. Since the instrument connected to the probe can detect as little as five *billionths* of an inch of metal loss, the concentration of the corrosive compound can be quickly detected even though it is extremely small. By "sensitizing" the metal surface beforehand with a chemical treatment, the progress of corrosion can be detected literally atom by atom.

Circle No. 236 on Subscriber Service Card.

Viton-to-Metal Gaskets

Stillman Rubber Company has announced acceptance by the aircraft/missile industry of its new Still-Seal Gaskets for sealing hot fluids.

The gasket design incorporates bonding of duPont Viton to carefully engineered metal gaskets to achieve absolute sealing of hot fluids in the fuel, air and liquid systems of aircraft and missiles. Because of the many shortcomings of most rubber compounds in the presence of hot hydrocarbons and other materials, it has long been a design problem to accomplish a positive seal in hot fluid systems. It was quickly apparent that Viton would resist the deteriorating ef-

ects of these hard-to-handle hot fluids f it could be combined with a metal gasket which would hold the Viton eal in place under a wide range of pressures and temperatures.

Circle No. 237 on Subscriber Service Card.

Miniature Free Gyro

Giannini Controls Corp. has developed a two-axis free gyro which measures 4in. x 2.75in. dia. and weighs less than 2½ lbs.

Equipped with a synchro-type pickoff on the outer gimbal, the 3417 Gyro

is ideal for missile guidance where a small yet reliable instrument is required. The rugged unit will withstand 40 g acceleration and shock, and will operate over a temperature range of –54°C to 71°C.

Circle No. 238 on Subscriber Service Card.

Telemetry Signal Simulator

Telemetrics, Inc. has produced a telemetry electronic signal simulator, Model ESS-200, which simulates an accurate PAM pulse train for use in accurate calibration and checkout of telemetry ground stations.

The ESS-200 provides pulse and frame rates conforming to IRIG standards, and other rates between 6 pps and 3600 pps. Negative and positive variable output signals are available with provisions for introducing missing pulses. Linearity and stability are within 0.2%. The noise and crosstalk are less than 0.1%. The ESS-200 is only 5.25 in. high and fits a standard 19-in. relay rack.

Circle No. 239 on Subscriber Service Card.

Dust-Free Cabinet

Specialaire, a dust-free illuminated work chamber with double filtration for maximum air cleanliness, is now available for standard work benches. The self-contained cabinet was designed to provide high dust arrestance for assembly, research and test of ball bearings, optical components and other precision instruments in both cleaned and non-cleaned areas.

Rejects due to dust contamination are eliminated by use of the new portable cabinet, whose continuous flow of filtered air prevents fine dust particles from entering the work area. The cleaned air passing out of the cabinet acts as a shield against lint, pollen, dust or dust-borne bacteria. The self-charging electrostatic filtration has an arrestance value of 95% on dust particles ranging from .08 to 80 microns in diameter.

Circle No. 240 on Subscriber Service Card.

Anti-Weld Grease

Lehigh Chemical Company is marketing a synthetic anti-seize compound for extreme high-temperature applications.

Called Anderol L-751, it is a mixture of a thermally stable silicone oil with a solid-type lubricant blended to the consistency of a medium soft grease. Its excellent thermal stability and anti-weld properties meet requirements for high-temperature ranges of 400°F. to 600°F.

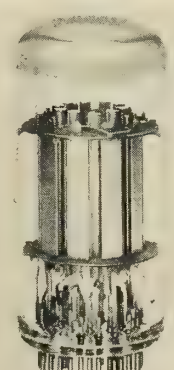
Anderol L-751 is available in 1-lb. and 5-lb. cans, 14-oz. cartridges and 35 lb., 100-lb., and 400-lb. drums.

Circle No. 241 on Subscriber Service Card.

New Switch Design

The Beam-X, a new decimal electronic switch, is expected to effect a major change in basic electronic design logic from binary to decimal systems, according to Burroughs Corporation's Electronic Tube Division. The Beam-X Switch uses small rod magnets within a vacuum to control the position of an electron beam to any one of ten output positions.

The result is a decimal switch so



reduced in size, weight, cost and power requirements as to outperform all existing vacuum, magnetic, and solid-state devices in multiposition switching, counting, distributing, multiplexing, and allied operations. In a typical ten-position switching application, the new Beam-X decimal switch eliminates the 90 transistors, diodes, and resistors which must be used with binary logic to achieve the same results.

Circle No. 242 on Subscriber Service Card.

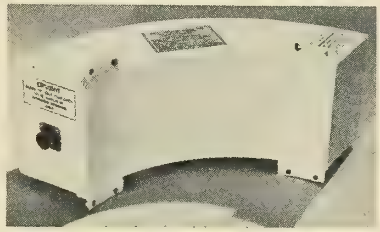
Low-Density Fillers

A new resin-compatible, low-density filler, called Globe-O-Sil, is offered by Hastings Plastics, Inc.

Globe-O-Sil is described as a hollow sphere of silicone dioxide whose outstanding features include a low density of four pounds per cubic foot, 2300°F melting point, good floatability, white color, three hundred to six hundred micron size, and low cost.

Circle No. 243 on Subscriber Service Card.

Contour Batteries



A "configured" silver-zinc primary battery has been designed for missile APU systems by Cook Batteries, a subsidiary of Telecomputing Corp. The Model P58A is an automatically activated 20-cell unit shaped to an 88° arc. Battery size is 11 x 5 in. It weighs only 13 lbs.

The battery has a capacity of 7 ampere-hours, and produces 14 amperes at 28 volts. Maximum current is 50 amps. Discharge time is 30 minutes at 14 amperes.

Circle No. 244 on Subscriber Service Card.

Quality Etched Surfaces

High-quality etched surfaces can be prepared in a matter of minutes by inexperienced personnel using Nuclear Materials and Equipment Corp's Cathodic Vacuum Etcher, Model 4CVE.

Samples mounted by conventional techniques may be analyzed and various types and degrees of etching can be obtained, from very light to very deep, through proper selection of operating conditions.

Model 4CVR, a remote version of the 4CVE, is designed particularly for use with irradiated materials.

Circle No. 245 on Subscriber Service Card.


Motorola
VISITOR

Man still top machine . . .

Astronauts Will Earn Their Way

by an M/R Correspondent

Few people remain who believe that manned flight into the cosmos will be a joyride. With this in mind, many influential scientists have queried the role of man in space, and suggested that modern technological instruments can do more, cheaper and quicker.

The argument would seem to be convincing, backed up as it is by vast amounts of data relayed from space by U.S. and Russian satellites and space probes—especially the excellent and unconfused photographs of the hidden side of the moon by *Lunik III*. In contrast, statements about the flexibility of the human and his ability to do the work of several machines appear vague and inconclusive.

Nonetheless, man-in-space has a role that goes beyond the vanity of *Homo sapiens*—a job in which the astronaut can justify his voyage in simple terms of feasibility and the payload. The astronaut can more than establish his claim to priority because of the many intangibles to which he may prove much more adaptable than any collection of machines.

• **Sun-period 126?**—The price of conquering space will not be small, whether it's done with instrumented probes or manned vehicles. At first glance some possible endeavors look hardly worth the effort.

One example is the sun-period space laboratory, in which a spaceship orbits as a satellite of the sun at a speed equal to the angular rotation of some latitude of the non-uniformly spinning solar surface. From this vantage point, a surface phenomenon such as a sun-spot could be studied continuously over a long period.

But, apart from the great engineering problems it poses in the form of long-term attitude control delayed-thrust restarting, communications and heat protection while orbiting as close as 15 million miles to the sun, the injection of the stationary solarium laboratory into orbit demands enormous velocity—of the order of 130,000 feet per second. A rocket such as the 250-ft.-tall, six-million-pounds-thrust *Nova* might be able to put a 10-lb. payload into such an orbit, using liquid hydrogen to fuel the earth take-off stages, and a storable propellant for the final transfer impulse. For the station to survive a day, half of its weight in orbit would have to be used for heat protection, since the platform would receive as much radiant heat in two weeks as a similar body at an earth distance would receive in a year. And there would still be the need to communicate with the earth—nearly a hundred million miles away.

Nevertheless, it is conceivable that an experiment into solar processes from such a stationary platform could bring control of nuclear fusion much closer to realization. Is it worth the effort?

Unfortunately, there is no simple answer. The only safe conclusion is that the mode of propulsion should be quite different from present-day rocket practice, perhaps taking advantage of the increased solar radiation flux to increase the ratio of payload to propulsion weights.

• **Manned rendezvous**—At this juncture it seems appropriate to mention the techniques of manned rendezvous, which, coupled with rocketry improved beyond the conventional chemical fuels, could destroy existing prejudices towards the stationary solarium and most other deep space missions.

Rendezvous operations have some appeal for construction or maintenance purposes; they would aid the exploitation of complex space systems such as the 24-hour orbit television relay by adding somewhat to the feasibility and potential lifetime of the system. As for manned space journeys, it is difficult to see how they could be accomplished without resorting to orbital assembly methods, even for flights to the moon.

A take-off thrust of 10 million pounds or more would be needed if a rocket were to fly directly to the moon, land and return to earth, assuming it relied on chemical propellants of a storable character and carried a crew of two or three astronauts. Such a rocket is not even in the planning stages today.

The use of rendezvousing does not ordinarily reduce the fuel required for a mission; on the contrary, it increases it—both on account of the need for rendezvous maneuvers and because of departure via a satellite orbit. The advantage offered by rendezvous is the feasibility it adds by reducing size and weight of the rocket vehicle. Practic[al] secondary advantages are inherent in improved reliability, lower cost and con[]densed time-scale.

• **'Astrotugging'**—When the variou[s] available methods for rendezvousin[g] spaceships are compared, it become[s] clear that success can be mor[e] readily assured if humans are used and that the use of an astronaut-har[]poon device, an extravagant version o[f] which has been called an "astrotug," would save considerably in fuel ex[]penditure, compared to a purely me[]chanical procedure.

On a typical mission, the sequenc[e] of rendezvous operations is compli[]cated and varied, and involves a num[]ber of human decisions, but the flexi[]bility of the human is such that a[n] event that would have aborted the en[]tire launch in the automatic system would be merely a source of delay i[n] the astronaut-harpoon berthing opera[]tion.

Where primary assembly is in[]volved—and this should be just abov[e] the earth's atmosphere, both to con[]serve fuel and to avoid radiation ex[]posure—the subassemblies would b[e] launched into a temporary cluste[r] orbit. Payloads whose orbits are grossl[y] misplaced would be rejected and re[]placed, and—since they are primaril[y] fuel tanks—could be used later o[n] other missions.

The first decision would be th[e] order in which the subassemblie[s] should be intercepted; this is importan[t] because it would determine the inpu[t] parameters for the initial maneuve[r] and largely influence the quantity o[f] fuel that would be consumed in th[e] succeeding rendezvous. The second de[]cision would be how much time t[o] allot for the initial maneuver; this i[s] likely to be the most expensive singl[e] velocity outlay, and if the cluster ele[]ments were widely scattered, it migh[t] be safest to transfer orbits slowly, con[]serving fuel.

Time, however, is at a premium o[n] space voyages, and generally it is pref[]erable to avoid slow-transit, least-en[]ergy transfer and to exploit instea[d] fixed transfer time or fixed fuel tra[]jectories. What to do in a particula[r] circumstance is a tricky problem de[]manding skilled judgment on the par[t] of the spaceship commander.

• **Harpooning**—When the first uster was approached, the astronaut-arpoon would be launched. The shell-ke structure would be visually guided the component payload and a nylon ord that had been paid out from the arent ship would be made secure by eans of mechanical hands operated y the astronaut.

If the two rendezvousing ships were oing too fast relative to one another, ne cord would be automatically re-ased before it was subjected to a estructive tension. Before this hap-ened, the pilot of the parent ship ould fire a vernier rocket to reduce ne relative speed—a decision he would kely favor if the otherwise ensuing elay were expected to have serious onsequences.

A spin would be imparted to the ehicles through attachment and sub-equent winding in of the cord; atti-ude stabilization would be required to liminate the spin before the next ren-ezvous was attempted.

• **Other possibilities**—Besides pri-nary assembly just above the earth's tmosphere, rendezvousing can be used o advantage about other plants and he moon. If atmospheric heating and eceleration were unimportant, as with he atmosphere-free moon, it would be nnecessary to waste fuel by landing he earth return payload. This could e left in orbit along with fuel for the eturn trip.

In this fashion, the efficiency of the manned lunar expedition could be just about doubled. Initially beyond the capability of even a *Nova* rocket, it is brought by manned rendezvousing within the grasp of a handful of *Atlas-Centaurs,* or two *Saturn* rockets, with the proper combination of oxygen-hydrogen and storable propellant upper stages.

The stationary solarium laboratory, allegedly the most important deep-space mission in terms of knowledge it might provide, would influence life on earth, yet would not likely be a mission to which humans are as-signed. But it would be brought much closer to possible realization by com-bining rendezvous assembly methods with some form of propulsion, such as the solar turbine, that alters the mass ratios completely.

Assembly operations—achieved by rendezvousing—represent a major con-tribution to space technology by the astronauts themselves. The rendezvous-trained astronaut is not yet spent. Icarus and Hermes are just two of several important asteroids that come very close to the earth at some stage of their eccentric orbits through solar space.

Both are small planetoids, about a mile or so across, but they have some very interesting orbit characteristics. Icarus falls within 17 million miles of the sun, passes the earth at four million miles and finds its aphelion beyond the constellation of Mars. It is nature's own solar probe, with the smallest asteroid orbit known.

Hermes is even more spectacular—it gets between the earth and the moon on certain phases of its trajectory.

These planetoids are worthy of ex-ploration. When they make their nearer approaches to earth, expeditions should be dispatched to them. The landing would not be appreciably different than rendezvousing two spaceships; similar human operations would be required.

Perhaps, if Icarus has not developed dangerous radioactivity from its con-stant proximity to the sun, it would prove possible to dig a cave which would act both as a heat shield during the perihelion passages and as protec-tion against space radiation hazards such as solar flares.

Manned journeys into deep space may be long delayed on account of the weight penalty of the radiation shield; hitch-hiking on an asteroid may be an acceptable way out of the dilemma.

The astronaut has a job to do, and a place, in space flight. He will truly work his passage.

Firebee in production

T. CLAUDE RYAN, (third from left) President of the Ryan Aeronautical Company, joins Air Force and other Ryan officials in inspecting the first *Firebee* target missile to roll off the Ryan production lines.

GE Official Sees Hazards In 'Guardian Angel' Buying

The "Guardian Angel" principle in military procurement is picking the taxpayer's pocket—and could be dis-astrous in 10 years, charges a General Electric Co. official.

The principle of looking out for the smaller firms in military purchasing is a result of public misconception about "opposition" between large and small businesses—creating a political issue, according to L. Berkley Davis, general manager of GE's Electronics Components Division. In an article written for *The General Electric De-fense Quarterly,* Davis declares that such opposition does not exist, and actually large and small defense con-tractors are dependent on one another for tasks they cannot economically handle themselves.

He feels that without the large-scale company to break a project into smaller pieces the small firm could not participate. He adds; "roughly 53 cents of every defense dollar received by General Electric is passed along to small suppliers."

Mirror to Weigh 4 Tons

The mirror for the new Crimean Astrophysical Observatory telescope will have a diameter of 2.6m and weigh 4 tons, according to *Pravda.* It is now being completed in the Leningrad Optical Plant.

contracts

AIR FORCE

$474,831,000—**Radio Corp. of America**, New York City, for work on the Ballistic Missile Early Warning System.

$172,365—**Boeing Airplane Co., Pilotless Aircraft Div.**, Seattle, for modification kits applicable to *IM99A*.

$82,500—**Sverdrup & Parcel Engineering Co.**, St. Louis, for initial design of vertical rocket engine altitude test cell.

$60,623—**Boeing Airplane Co., Pilotless Aircraft Div.**, for data in support of the *IM99A* missile, and tool replacement of ramjet fuel expulsion diaphragm (two contracts).

$40,990—**Electro Mechanical Research, Inc.**, Sarasota, Fla., for repair and modification of telemetry equipment.

NASA

$91,745—**Beckman & Whitney, Inc.**, San Carlos, Calif. for high-speed motion picture camera for high-speed impact studies in the Hypervelocity Ballistic Range, NASA, Moffett Field.

$66,433—**Ampex Corp.**, Birmingham, Mich., for magnetic tape recording system for Lewis Research Center.

NAVY

$292,539—**General Dynamics Corp., Electric Boat Div.**, Groton, Conn., for a design study in connection with the installation of nuclear submarine type auxiliary electrical and propulsion components and systems.

$66,493—**Lenkurt Electric Co., Inc.**, San Carlos, Calif. for communication equipment.

$30,515—**Panoramic Radio Products**, Mt. Vernon, N.Y., for panoramic telemetering indicator.

$27,736—**Rese Engineering, Inc.**, Philadelphia, for random-access magnetic core memory system.

ARMY

$82,799,690—**The Martin Co.**, for *Pershing* (two contracts).

$2,667,475—**Douglas Aircraft Co.**, Santa Monica, for *Nike-Hercules* missile launching area items.

$2,198,253—**California Institute of Technology**, Pasadena, for research and development of guided missiles.

$1,213,508—**Raytheon Co.**, Andover, Mass., for replenishment and repair parts for *Hawk* missile system (two contracts).

$1,138,475—**California Institute of Technology**, for wind tunnel testing for *Nike-Zeus* (two contracts).

$1,028,392—**Sperry Rand**, Salt Lake City, for research and development and repair parts for *Sergeant* guided missile system (3 contracts).

$935,367—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering and design services and specialized services for manufacture of special tooling and missile components—supplementary (two contracts).

$481,500—**Aerojet-General Corp.**, Azusa, Calif. (classified).

$400,000—**Gilfillan Bros., Inc.**, Los Angeles, for *Nike* system components.

$288,332—**Douglas Aircraft Co., Inc.**, Santa Monica, for *Nike* replenishment spare parts (two contracts).

$247,652—**Brown Engineering Co.**, Huntsville, for engineering and design services.

$188,892—**The Martin Co.**, Orlando, replenishment spare parts and components for *Lacrosse* missile.

$95,000—**General Electric Co.**, Burlington, Vt., for engineering design and development on *M61 (T171E3)* and fabrication and testing of mechanical accessories and components.

$72,025—**Task Corp.**, Anaheim, Calif., for wind tunnel test equipment for *Nike-Zeus*.

$57,319—**Radioplane Div. of Northrop Corp.**, Van Nuys, Calif., for *Hawk* target missile flight services.

$46,860—**Redstone Machine & Tool Corp.**, Huntsville, for manufacturing fabrication of missile test components and fixtures.

$48,823—**Western Electric Co., Inc.**, New York City, for electron tubes.

$45,000—**North American Aviation, Inc.**, Canoga Park, Calif., for rocket engines.

$43,270—**Brown Instrument Div., Minneapolis-Honeywell Regulator Co.**, Philadelphia, for potentiometer recorders, various numbers of pens for meteorological recording.

$33,040—**University of Cincinnati**, continuation of studies in septic and irreversible shock.

$29,160—**Technical Appliance Corp.**, Sherburne, N.Y. for electronic satellite tracking equipment, antenna arrays.

$28,909—**Heiland Div., Minneapolis-Honeywell Regulator Co.**, Denver, for oscillograph, direct recording with galvanometers and amplifier system.

RE Convention Covers Military Work

Following are abstracts of papers esented at the 1960 Winter Military lectronics Convention in Los Angeles. he conference was sponsored by the stitute of Radio Engineers' Profesonal Group on Military Electronics. urther information on the papers may obtained from the IRE, 1 E. 79th ., New York 21, N.Y.

ngle Aperture CW Radar Techniques, . R. Boughnou and W. S. O'Hare, Rayeon Company, Maynard, Mass.

In the past, CW Radar has not been nsidered for many airborne applications ainly because of inadequacy of transmitng tubes and the requirements for two ntennas.

Improvements in tubes for CW transmitrs have made possible advances in techiques for single-dish CW radar.

The principles of the basic single-dish dar system are discussed along with the sults of experimental programs.

. Satellite Navigation System Employing Synchronized Pattern, G. E. Townsend, Kork, and J. D. Kraft, The Martin ompany, Missiles and Electronics Diision, Baltimore.

Detailed investigations of the means by hich a satellite may be navigated in the icinity of the earth have uncovered few ew techniques which are capable of proiding the required navigational accuracies.

However, one new approach has reealed a promising technique employing a ynchronized pattern of satellites. This is ased on the measurement of position and elocity with respect to those of three isible satellites and requires as inputs only hree simultaneous measurements of range nd range rate.

atellite Auxiliary Power Systems, Nels . Palmquist, Jr., Satellite Systems ranch, Lockheed Aircraft Corp., Misile and Space Division, Sunnyvale, Calif.

The general requirements of auxiliary ower systems for satellites are presented, n particular those of the *Discoverer II* ehicle.

The auxiliary power system is formulated nd its flight performance is evaluated. A rief look at future systems such as solar hotovoltaic, nuclear, thermoelectric, and igh-energy batteries is also presented.

***xplorer VI* Digital Telemetry-TELEBIT,** . E. Gottfried, Space Technology Laboratories, Inc., Los Angeles.

The digital telemetry system, TELEBIT, ow aboard *Explorer VI*, is described. Some f the design considerations and the actual mplementation are discussed.

ommunications System for Project *Mercury* Space Capsule, William Benner, McDonnell Aircraft Corp., St. Louis.

The basic capsule for Project *Mercury* relies heavily on the system of communications with ground stations. This system employs several different communications paths: HF voice, UHF voice, commands from the ground, telemetry from the capsule, as well as beacons for radar tracking and recovery. To insure continuity of operation, multiple techniques and supplementary modes provide reliability and redundancy.

The problems and solutions described should find application in other military electronic programs.

Specialized Reconnaissance Techniques, James C. de Froekert, Stanford Electronics Labs., Stanford University, Stanford, Calif.

Several new techniques for signal sorting reconnaissance applications are described. The techniques to be discussed include: (1) pulse-by-pulse frequency measurement on an instantaneous basis over a wide range of frequencies, (2) identification of simultaneous and sequentially pulsed radars, (3) indication of frequency-jumping systems, and (4) unusual data recording techniques.

An AN/AAS-5 Infrared Reconnaissance System, W. B. Birtley and D. D. Chaffee, Jr., HRB-Singer, Inc. State College, Pa.

Described is an IR reconnaissance system developed by HRB-Singer, Inc., for airborne use by the Army Signal Corps. The system is unique in that it is a dual channel arrangement using two detectors simultaneously and employing interchangeable detector-preamp assemblies.

Also discussed is a nitrogen liquifier for supplying detector coolant in the field. Transistor circuits unique to IR detectors and IR systems are also mentioned.

A Stationary Sun Position Sensor, G. C. Anthony, IBM, Military Products Division, Owego, N.Y.

A description of a stationary sun position sensor system which determines one axis of a coordinate reference system in interplanetary space. Total orientation of the vehicle may be established when the sensor system is used in conjunction with a sighting telescope to establish a second axis. The sensor system will provide space axis rates about two of the three inertial axes. In addition, the sensor will supply attitude information for orienting solar cells or sun sensing instruments toward the sun.

Development of Portable Atomic Frequency Standard for Missile-borne and Satellite-borne Applications, Dr. M. L. Stitch and Dr. H. Lyons, Hughes Research Laboratories, Hughes Aircraft Company, Culver City, Calif.

Work under way at HAC may lead to a missile-borne atomic frequency standard of the ammonia maser type with long-term frequency stability of three parts of 10^{11} or better and short-term stability of five parts in 10^{12} or better. Some of the problems associated with development for different classes of applications are discussed.

The possibilities of an ammonia maser type frequency standard are explored, together with the relative merits of the ammonia maser type frequency standard as compared to other types.

Cryogenic Gyros, W. H. Culver and M. H. Davis, The RAND Corp., Santa Monica, Calif.

Effects unique to very low temperatures offer some interesting new approaches to gyro design. The phenomena of superfluidity and superconductivity and the general mechanical stability of materials at a temperature of a few degrees Kelvin make it possible to realize certain idealized conditions in practice. A gyro design making use of some of these phenomena is described.

Basic Principles of Fuzing High Explosive Warheads for Use Against Air Targets, V. A. Brown and A. V. Sylwester, U.S. Naval Ordnance Lab., Corona, Calif.

The objective of the fuze designer is stated in terms of burst control requirements. The missile-target encounter is described and illustrated in terms of a convenient target-centered frame of reference. The effects of the conflicting requirements imposed by the wide variation in encounter parameters, such as target size, relative velocity, intercept aspect, miss distance, and altitude are discussed. The influence of warhead characteristics upon burst control requirements is treated, and there is a brief survey of the ability of various methods of target detection to meet burst control requirements.

Missile and Satellite Detection System, H. Kilberg, RCA Service Co., Patrick Air Force Base, Fla.

The Frequency Control and Analysis program of the future at the Atlantic Missile Range is largely governed by the requirements of detecting and tracking missiles and satellites, both cooperative and non-cooperative, to obtain orbital data in support of Project *Space Track*.

Antenna systems, receiving systems, and signal converter and analyzing systems are the areas of development where special work was done by the FCA Laboratory of the AMR.

Components are described, and the reasons for their selection, as well as their limitations, are discussed.

Ballistic Missile Space Communications System Concept, Charles A. Strom, Jr., Rome Air Development Center, Griffiss AFB, N.Y.

This paper summarizes many of the factors of the communications system that tend to restrict or affect the total ballistic missile system performance. Suggestions are made of elements of the communications system that should be considered early in the development program to better integrate

the communications subsystem with the overall system. Promising new developments and the techniques which will overcome some of the deficiencies of today's communication subsystem support to the ballistic missile and space flight systems are highlighted

Sub-Surface Radio Communications Links, H. A. Norby, Space Electronics Corp., Glendale, Calif.

The historical background of sub-surface electromagnetic communication and its propagation theory is discussed briefly. Recent field test data obtained at the Boron Test Site of Space Electronics Corp. is included and used as the basis for a brief discussion of the relationships between range, power, noise level, and information rate.

Development status of sub-surface radio communication is summarized and preliminary design criteria for potential system applications are presented.

Re-entry Radiation from an IRBM, Dr. W. N. Arnquist, System Development Corp., Santa Monica, Calif.; D. D. Woodbridge, U.S. Army Ballistic Missile Agency, Huntsville, Ala.

The radiation emitted when a high speed body re-enters the atmosphere is an important source of information concerning the physical processes taking place. For about two years the Army Ballistic Missile Agency has conducted a measurement program known as Project *Gaslight* which has utilized *Jupiter* firings, and, to a limited extent, both *Thor* and *Polaris* firings. An account is given of the instrumentation employed and some of the results obtained.

Re-entry Guidance and Flight Path Control, James E. Vaeth, The Martin Company, Missiles and Electronics Division, Baltimore.

This paper discusses the abilities and limitations of a specific flight path control law for range maneuvering during the atmospheric phase of re-entry from orbit, as determined by a digital computer study. Results of the study demonstrate that a relatively simple guidance and flight path control loop, utilizing a preprogrammed normalized trajectory plus vehicle velocity and range-to-go measurements, is very effective; range dispersions of more than ± 100 miles, due to initial conditions or to uncertainties in lift-to-drag ratio, are reduced to less than one mile. Variations in terminal accuracy are evolved as functions of control law gain, velocity measurement errors (via inertial guidance or ground radar tracking) and severe headwinds.

High Accuracy Telemetry for *Sergeant* Weapon System, W. Arens, Jet Propulsion Laboratory, Pasadena, Calif.

This paper discusses the design and development of a telemetering system for the *Sergeant* weapon system capable of attaining an accuracy of reproducibility of a 0.1% of full scale for a limited number of guidance system performance characteristics.

Recent Advances in Transistorized Telemetry, Joe H. Smith, Texas Instruments Inc., Apparatus Division, Dallas.

This paper covers specific areas in which Texas Instruments has made notable achievements during recent months. Specifically discussed are: (1) a highly flexible and reliable 8-bit PCM system with low-level capabilities, (2) high-and low-level solid-state multipliers, (3) transistorized transmitters and subcarrier oscillators designed to rigid requirements of *Mercury*, *Centaur*, and *Vega*.

The AN/DPN-63 Subminiaturized C-Band Transponder, Liscum Diven, Fredrick L. Koch, Motorola, Inc., Western Military Electronics Center, Phoenix.

The AN/DPN-63, a subminiaturized C-Band transponder designed to extend the tracking range of the AN/FPS-16 Radar, incorporates a number of advanced design techniques.

The volume of this C-Band transponder is less than 100 cubic inches including batteries. With the exception of the 400 watt magnetron, silicon semiconductors are used throughout.

Exceptionally high transponder delay stability is required in order not to compromise the range accuracy of set AN/FPS-16 radar; the unique automatic gain control circuit to meet this objective is described.

The modulator uses a new semiconductor device to perform the switching function. Use of semiconductors in pulse modulators of various power levels and duty cycles is discussed, and a unique re-usable encapsulating method is shown.

Solids Meeting

Abstracts from ARS Princeton Conference

The American Rocket Society's Solid Propellant Rocket Research Conference was held recently at Princeton University.

Abstracts of a portion of the papers presented have been compiled and are presented as a service to M/R readers.

Further information may be obtained from the American Rocket Society, 500 Fifth Ave., New York 36, N.Y.

The Mechanism of Ignition of Composite Solid Propellants by Hot Gases, R. F. McAlevy, P. L. Cowan, and M. Summerfield, Guggenheim Jet Propulsion Center, Princeton University, Princeton, N.J.

Ignition of composite solid propellants of the ammonium perchlorate type has been accomplished in a shock tube filled with a mixture of oxygen and nitrogen. The time interval between the instant of contact of the propellant sample by hot gas and the subsequent emission of light as detected by a photocell, has been measured as a function of oxygen concentration for several different propellants. It was found that the ignition times varied inversely with the oxygen concentration.

A new theoretical approach has been developed for the ignition of a composite propellant by a hot gas, the essential element of which is that the flame first starts in the gaseous layer adjacent to the propellant. The observed ignition delay is simply the time required for enough fuel to vaporize to create a combustible gaseous mixture.

Combustion Instability in Solid Rockets Using Propellants with Suspended Metallic Powders, Sin I. Cheng, Princeton University, Princeton, N.J.

The stability of the acoustic oscillations in the chamber of a solid-propellant rocket is analyzed to reveal the effect of the addition of the metallic powders to a basic solid propellant. The dissipative action of the oscillation of the particles in the condensed phases is neglected. The oxidation of the metallic powders is considered as distributed heat sources to the gas system.

Heat Transfer Stability Analysis of Solid Propellant Rocket Motors in the Study of Resonant Burning, Reuel Shinnar and Menachem Dishon, Technion, Haifa, Israel.

This paper presents a theoretical investigation of the causes of unstable burning in solid-propellant rocket motors. A possible mechanism of unstable burning is developed. Small perturbation analysis is applied to a set of differential equations describing heat transfer in the solid as well as in the gas film near the burning surface. Criteria of instability are derived directly from the equations having only the physical properties of the propellant as parameters.

It is shown why an endothermic reaction at the decomposing surface of the solid propellant favors stability. The stabilizing influence of turbulators and radial holes drilled into the charge is explained.

The Slotted-tube Grain Design and Some Practical Modifications for Use by Grain Designers, Max W. Stone, Rohm & Haas Company, Redstone Arsenal Research Division, Huntsville, Ala.

A mathematical analysis was made of the internal-burning slotted-tube configuration which has some distinct advantages for certain solid-propellant applications. Those advantages are zero sliver, high loading density and thick web capability, low stress concentration, and mandrels that can be made in less time and more cheaply than star mandrels. The disadvantage centers in the fact that an insulating liner is required to protect the motor wall in the slot region.

The results of the mathematical analysis were programmed for an electronic computer and calculations made for a wide range of the parameters of interest.

names in the news

William J. Kuehl: Named manager-ngineering, General Electric's Light Military Electronics Dept., succeeding **O. H. Winn,** recently promoted to general manager of the Capacitor Dept. Kuehl, who joined GE in 1948, was formerly manager-Communication and Navigation Engineering, directing MED's *Polaris* fire control and guidance rojects.


KUEHL

Bryan F. LaPlante: Appointed director of The Mitre Corp.'s recently opened Washington, D.C., office. Was formerly assistant to the general manager and Congressional Liaison Officer of the U.S. Atomic Energy Commission, and recently with Joyce & Fisher Associates.


LaPLANTE

Warren P. Turner: Named product manager, military products and solid propellants, for the Energy Div. of Olin Mathieson Chemical Corp. Was formerly special assistant to the vice president and technical director for high-energy fuels. Prior to joining the firm in 1958, vas director of applications and contracts livision of Reaction Motors, Inc.


TURNER

Joseph H. Laurinec: Joins ASCOP, a livision of Electro-Mechanical Research, Inc., as manager of administration, responsible for production scheduling and planning operations. Was formerly engineering manager at The Martin Co.'s Denver Division, where he directed development and production of all nissile instrumentation systems, including round support, system checkout and data ecording systems.


LAURINEC

Charles T. Cosser: Appointed director of marketing for Lockheed Electronics-Newport Division. Previously directed narketing activities for Interstate Elecronics Corp.

Homer A. Ray, Jr.: Selected for the ewly created position of engineering asistant at Rixon Electronics Inc.

Previous posts: Manager, Engineering Div., Smith Electronics Inc., chief engineer and director of Photogrammetry, Inc.

James Hannum: Formerly of Hughes Aircraft Co.'s communications division, joins Houston Fearless Corp. as manager, communications research.

Howard Speer, of Hughes Communications division, also joins the company's research group as senior staff engineer.

George H. Stoner, Boeing Airplane Co.'s program manager for *Dyna-Soar*, named the following to his staff:

William E. Ramsden, assistant program manager; **Benson Hamlin,** system manager; **Paul Sanders,** customer requirements manager; **Ellis Levin,** systems growth manager; and **Robert F. Watt,** program planning and control manager.

Ramsen, with the company since 1930, joined the *Dyna-Soar* group early in January after serving as program manager for development of the B-70 wing. Hamlin was project manager for Bell Aircraft Corp. on the advanced rocket boost glide weapon system (ROBO), later designated *Dyna-Soar*. Sanders, with the company since 1950 joined the program in 1957 as engineering representative in the Dayton, Ohio, office. Levin joined the company in 1942 to participate in gas turbine and guided missile research. Watt has been with the company for 22 years, working in nuclear propulsion.

Dr. T. Paul Torda: Named director of propulsion and fluids research at Armour Research Foundation of Illinois Institute of Technology. Was formerly professor of mechanical engineering at the Polytechnic Institute of Brooklyn.

Dr. Victor B. Corey: Appointed vice president, United Control Corp., responsible for development of precision components. Previous posts: Technical director, Donner Scientific Co.; executive engineer, Electronics Div., Willys Motors.

Dr. Alex J. Paszyc: Manager and chief engineer, Architect-Engineer Div., Pacific Automation Products, Inc. Previous posts: chief engineer, J. H. Pomeroy & Co., Inc.; project manager, Ralph M. Parsons Co.; project engineer, H. A. Simons, Ltd.

William H. Happe, Jr.: Formerly assistant general manager, promoted to general manager, Princeton Div., Curtiss-Wright Corp. Prior to joining the company in 1954, was director of IT&T Corp.'s Vacuum Tube Division.

Gen. O. P. "Opie" Weyland (USAF ret.): Named a consultant to Aerojet-General and a member of the corporate advisory board.

Thomas J. Carroll: Formerly with Philco, elected chief physicist at Semimetals, Inc.

when and where

FEBRUARY

American Institute of Chemical Engineers, Biltmore Hotel, Atlanta, Feb. 21-24.

Engineering Materials & Design Exhibition, Industrial and Trade Fairs, Ltd., Earls Court, London. Feb. 22-26.

British Interplanetary Society, London Branch, Institution of Plant Engineers, "Some Problems Encountered in the Design of Large Rocket Test Beds," Royal Society of Arts, London, Feb. 23.

National Association of Corrosion Engineers, Tulsa Section, 11th Annual Corrosion Short Course, Mayo Hotel, Tulsa, Feb. 24-26.

MARCH

Navy League Seapower Symposium, Sheraton Park Hotel, Washington, D.C., Mar. 1-3.

Royal Astronomical Society and Royal Meteorological Society, "The British Rocket Programme," Royal Society of Arts, London, Mar. 4.

British Interplanetary Society, "The Exploration of the Moon," Caxton Hall, London, Mar. 5.

Association of Mechanical Engineers, Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, Mar. 6-9.

Society of Instrument Technology, "Data Reduction for Guided Weapon trials at Aberporth," Manson House, London, Mar. 7.

Heat Transfer Symposium, Mechanical Engineering Dept., University of Florida, Gainesville, Mar. 7-8.

Society for Aircraft Material and Process Engineers, Midwest Chapter Symposium, "Processing Materials for Re-entry Structures," Miami Hotel, Dayton, Ohio, Mar. 9-10.

Mechanical Properties of Engineering Ceramics, North Carolina State College School of Engineering, and Office of Ordnance Research, US Army, NC State College, Raleigh, Mar. 9-11.

National Flight Propulsion Meeting, Institute of the Aeronautical Sciences, (classified), Cleveland, Mar. 10-11.

Electronics Industries Association, Defense Planning Seminar, Statler Hilton Hotel, Washington, D.C., Mar. 15.

Symposium on Optical Spectrometric Measurement of High Temperatures, sponsored by University of Chicago's applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation, at University of Chicago, Mar. 23-25.

22nd Annual American Power Conference, sponsored by Illinois Institut of Technology, American Society o Mechanical Engineers and others Sherman Hotel, Chicago, Mar. 29-31.

APRIL

University of Connecticut, Sixth annual Advanced Statistical Qualit Control Institute, Storrs, April 3-15

Solar Energy Symposium, America Society of Mechanical Engineers and Mechanical Engineering Dept University of Florida, Gainesville April 4-5.

1960 Nuclear Congress: "What Will th Future Development of Nuclea Energy Demand From Engineers? sponsored by 28 engineering, scientific, management and technica organizations. Includes 6th Nuclea Engineering and Science Conference; 8th NICB Atomic Energy i Industry Conference; 6th International Atomic Exposition, New York Coliseum, New York City, April 4-7.

American Chemical Society, 137th National Meeting, Cleveland, April 5-14.

American Rocket Society, Structura Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, April 6-8.

Institute of Environmental Sciences 1960 National Meeting, "Hyper Environments — Space Frontier," Biltmore Hotel, Los Angeles, April 6-8.

Royal Aeronautical Society, Coventry Branch, The Optimum Size o Rocket Engines, Coventry, England April 7.

Society of Instrument Technology, "Th Electronic Computer as a Unit i an Automatic Data-Processing System for Missile Trials" Overheu London, April 7.

ASME-SAM Management Engineerin Conference, Statler-Hilton Hotel New York, April 7-8.

IRE and ARS, Southern Ohio, Fourteenth Annual Spring Technica Conference, Hotel Alms, Cincinnati April 12-13.

British Institution of Radio Engineers Computer Group, "Guided Weapo Control," London, April 13.

Symposium on Chemical Reactions i the Lower and Upper Atmosphere Stanford Research Institute, Mar Hopkins Hotel, San Francisco April 18-20.

Advertiser's Index

CLASSIFIED

THE SYSTEM ENGINEER

The major function of the System Engineer is to assist his client in making sound system decisions and to develop plans and specifications which he can verify and support. He is a source of ideas about the kinds of systems which are appropriate and feasible. He understands the problems of designing and building the system components. He is qualified to examine new concepts and alternate designs and can relate the utility of proposals to cost and time. He can evaluate designs proposed by other agencies and contractors. He helps his client decide what to build and how best to build it. He translates these decisions into plans which can be carried out by other contracting agencies. He devises system tests and evaluates the operational capability of the subsystems and the integrated system.

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A brochure more fully describing MITRE and its activities is available on request.

Industry Needs a Hint From DOD

One of the more interesting—and critical—problems the defense industry faces these uncertain days is that of diversification—the broadening and increasing of in-house capability.

It not only affects the big primes in acquiring the smaller companies which will give them added skills and capabilities, but it also vitally concerns the little man. (If he isn't swallowed up, will he be frozen out?)

There are several points which emerge fairly clearly:

1. The possession of diversified facilities gives the big contractor a better basis of negotiation. As his own capabilities increase so does his grasp of the overall problem.

2. Diversification permits spreading of contracts. Most of the big companies would rather have one-fifth of five contracts than five fifths of one contract. This spreads the effect of a cancellation and mitigates the pain of the "hot poker and cold shower" treatment to which contractors are particularly sensitive.

3. It is not likely to affect the smaller, unmerged company for the same reasons which have made him successful in the past; his skills and his products cannot be supplanted in the eyes of either industry or government. He will have to be aggressive, ingenious and resourceful for he will find himself more and more in competition with the big primes.

There are other sides to the problem, however. In the past months the military services have made certain oblique changes in their procurement practices. Particularly is this true of the Air Force, largest of the military buyers and, more particularly, largest in the burgeoning missile/space business.

The Air Force has indicated it will itself maintain a greater in-house capability. Many of the management problems which in the past have been delegated to the prime or major contractor, the Air Force now intends to hold to itself. Gen. Schriever, AF R&D boss, has particularly emphasized it. This could mean greatly decreased responsibilities for the prime and a larger spreading of contract money.

Another factor in the situation is that several bills have been introduced in both chambers of Congress, such as S-422 by Senators O'Mahoney and Kefauver and HR-2325 by Rep. Celler. Both of these bills require prior notification to the government before mergers of defense industries of any size.

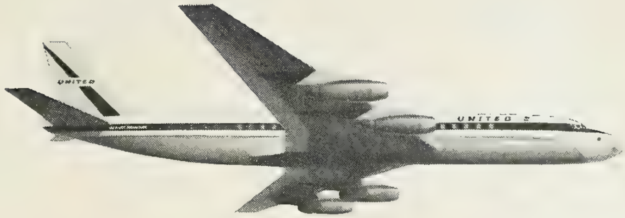
This one is thorny because mergers of corporations are not usually negotiated under the bright glare of publicity and the necessity of prior notification might throw a monkey wrench into many such deals from almost any angle.

It would seem logical that right now the defense industry would welcome some guidelines from the Department of Defense. The government of Great Britain has told its missile and aerospace business to merge and concentrate competition.

Would DOD like to encourage more defense industry mergers in this country? More diversification and in-house capabilities? Or would our Administration prefer to see as many companies as possible in the business, thus maintaining a broad mobilization base? Or is the attitude pure *laissez faire*?

Industry wouldn't necessarily follow such guidelines—but we suspect industry would strongly like some hints in accordance with changing times and changing procurement policies.

Clarke Newlon



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WO-DIMENSIONAL ELECTRONICS

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

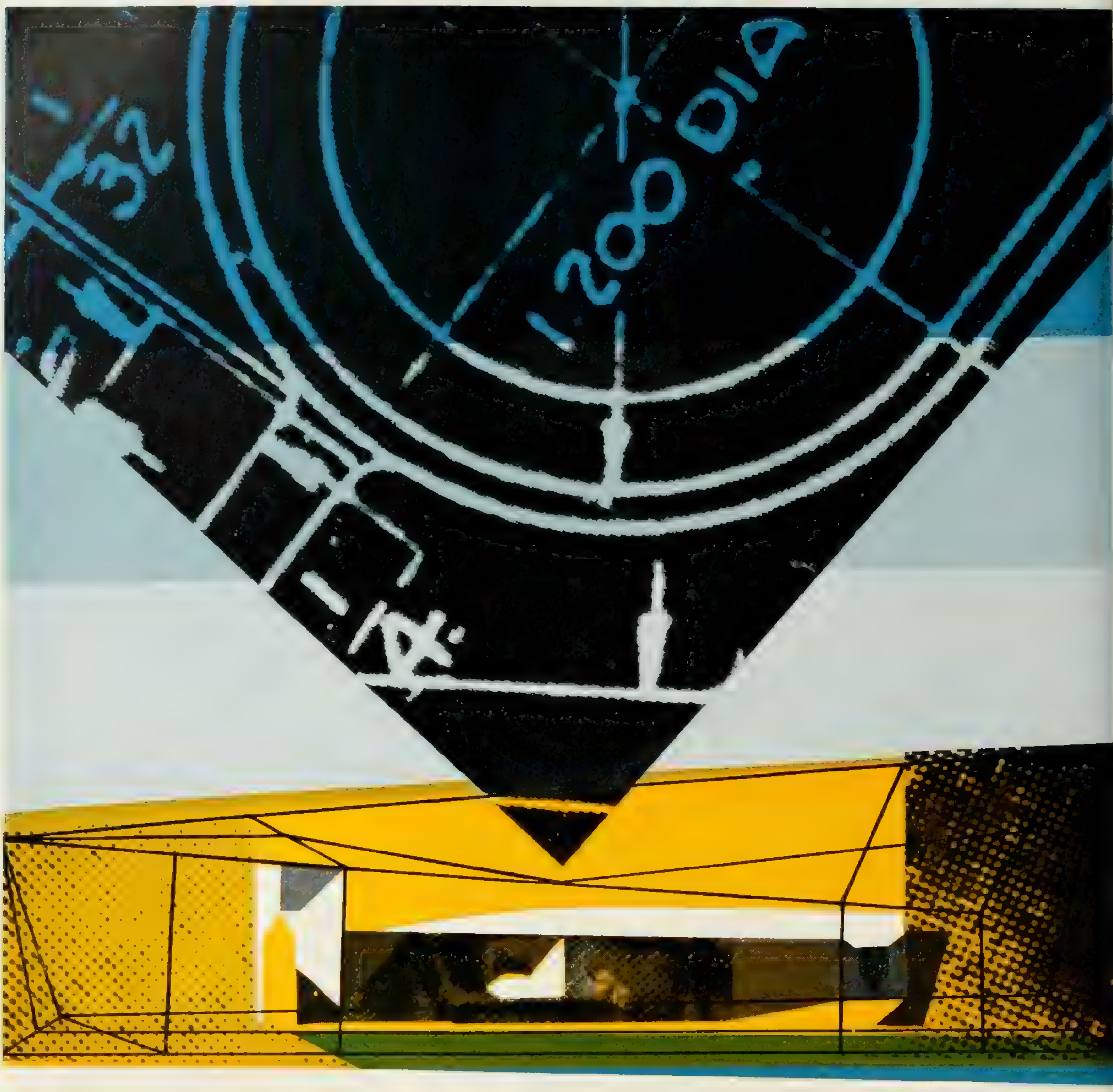
NUAL ASTRIONICS ISSUE

survey of the expanding technology
d a report on the growing market

AN AMERICAN AVIATION PUBLICATION

General Motors pledges

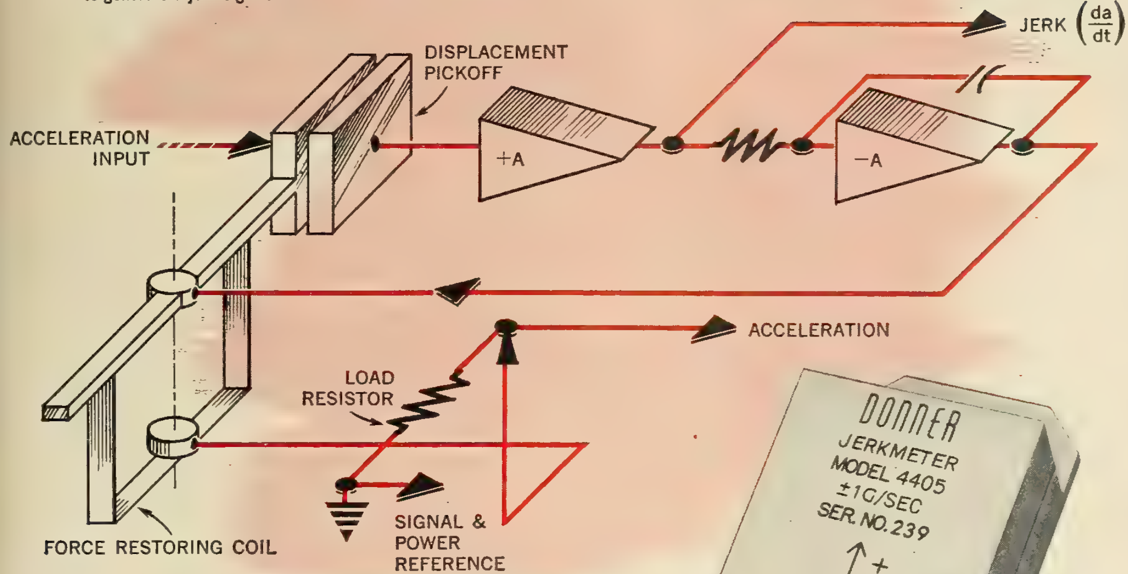
AC QUESTMANSHIP



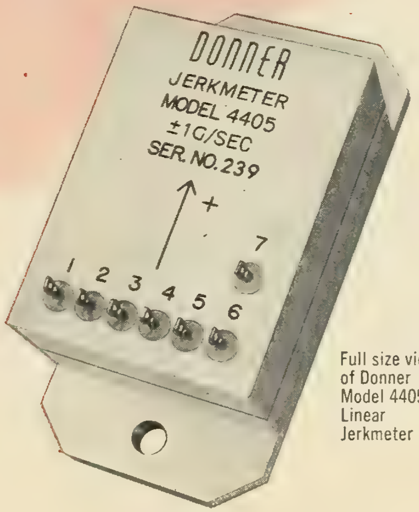
AC Seeks and Solves the Significant—Since GM has pledged its resources to this nation's defense, AC plans to forge to the forefront in the international race for technological superiority. The resolution of scientific problems even more complex than AChiever inertial guidance—that's what AC now has on its agenda This is AC QUESTMANSHIP. It's an exciting creative quest for new ideas, methods, components and systems . . . to promote AC's many projects in guidance, navigation, control and detection / Questmanship is readily apparent in AC Manufacturing, headed by Mr. Roy McCullough, AC Works Manager. His group "offers an outstanding challenge to engineers capable of understanding the most advanced scientific concepts . . . and developing the techniques and tools to implement those concepts on a production basis" There may be a position for you on our specially selected staff . . . if you have a B.S., M.S. or Ph.D. in the electronics, scientific, electrical or mechanical fields, plus related experience. If you are a "seeker and solver," you should write AC's Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin.

GUIDANCE / NAVIGATION / CONTROL / DETECTION / **AC SPARK PLUG** *The Electronics Division of General Motors*

● Functional diagram of Donner Linear Jerkmeter. This unique instrument operates as a subminiature servo-system of the force-balance type which is responsive to jerk along the sensitivity axis of the linear unit and about the sensitive axis of the angular unit. Basically, the system consists of a transistorized accelerometer with an integrator inserted into the servo-loop to generate a jerk signal.



HOW TO MEASURE $\frac{da}{dt}$



Full size view of Donner Model 4405 Linear Jerkmeter

New Donner precision Jerkmeters measure linear and angular jerk to ±0.5% or better.

If your measurement and control problem requires accurate measurement of jerk or the rate of change of acceleration, Donner Scientific's new line of precision angular and linear jerkmeters can help.

These new instruments are the only truly accurate device of this type ever made. They are designed to meet the most demanding applications. Both angular and linear jerkmeters provide an output voltage proportional to jerk which in turn can be used to instigate compensatory control forces or other actions. *An acceleration analog output voltage is also available.*

Typically, a jerkmeter installed in a jet aircraft will provide an instantaneous output proportional to the rate of change of g's. This signal can be used to predict impending disaster conditions.

Other applications include use wherever constant acceleration is required. Here, the Donner jerkmeter provides a "velocity-damping" term. The jerkmeter also provides a third order term for stabilizing displacement devices. It can also be used as an inertial indicator of first motion.

KEY SPECIFICATIONS
for Model 4405
Linear Jerkmeter

RANGES
Acceleration: ±1 g full range to ±30 g full range
Jerk: ±0.5 g/sec full range to ±20 g/sec full range

OUTPUT FULL SCALE
Accelerometer: ±7.5 v dc
Jerk: ±7.5 v dc

RESOLUTION
0.1% full scale or better

LINEARITY
0.1% full scale or better

HYSTERESIS
Less than 0.1%

POWER
+15 v dc at 10 ma and −15v dc at 10 ma

SIZE
3″ long, 1½″ wide, 1⅝″ high

WEIGHT
7.5 ounces

WANT MORE INFORMATION? *The new Donner Jerkmeter is another product from a firm specializing in the manufacture of accurate fixed and general purpose analog systems designed to analyze, measure, and control inputs interlocking time, acceleration, jerk, velocity, and other dynamic inputs. Complete technical information can be obtained by calling your nearby Donner engineering sales representative or writing Dept. 123*

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Missiles and Rockets Volume 6 Number 9

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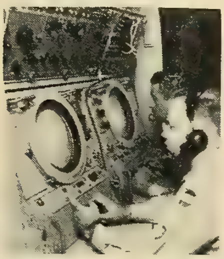
COVER: Engineer at Motorola's Solid State Electronics Dept. in Phoenix, Ariz., observes thin-film evaporation process. This still-developing art may produce complete electronic circuits thinner than this paper.

HIGH-SPEED magnetic tape relay by Datamatic Div. of Minneapolis-Honeywell is reported to be most efficient tape handling system yet. Major electronics trends are reported in review starting on p. 38.



TYPICAL of three-dimensional radar systems is Hughes FRESCANAR (Army's AN/MPS-23) which simultaneously detects, computes and transmits to missile batteries data on approaching targets. See story starting on p. 65.

SEVERE testing is applied to inertial guidance systems, like this model for the *X-15*, to establish accuracy and reliability. See a report on developments in guidance, p. 70.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

31,500 copies this issue

FEBRUARY 29 HEADLINES

PROPULSION ENGINEERING

ADVANCED MATERIALS

INTERNATIONAL

PRODUCTS AND PROCESSES

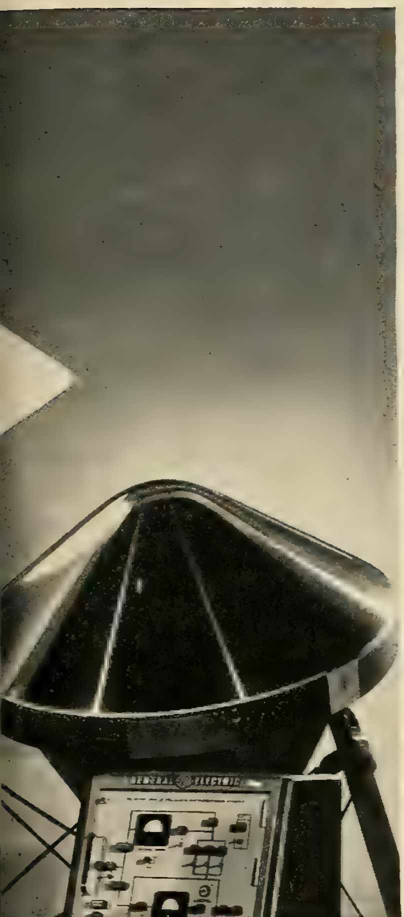
THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS

4000 subcontractors are represented re-entry vehicle "family portrait"

n this unique
lramatizing . . .



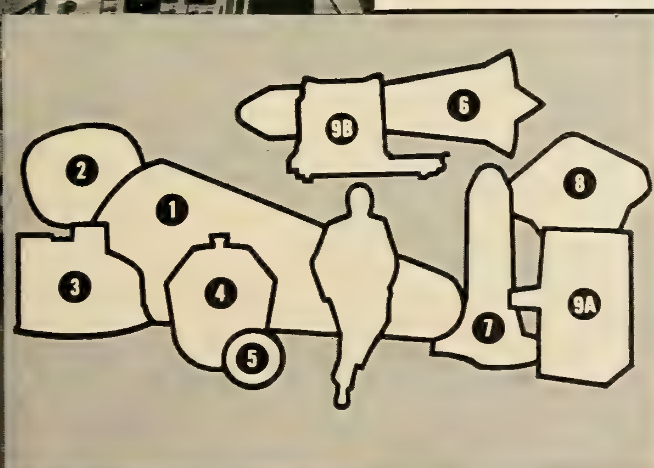
4 years of USAF, G.E., SUBCONTRACTOR re-entry vehicle progress

The key to this progress has been teamwork . . . teamwork between General Electric's Missile and Space Vehicle Department, the Ballistic Missile Division and the Ballistic Missile Center of the United States Air Force and the over 4000 small and large subcontractors alike who have helped MSVD make so many vital contributions to U.S. re-entry vehicle progress.

IN 1959 ALONE, the following figures indicate the emphasis MSVD placed upon this important factor of subcontractor teamwork on Air Force projects.

- Over 35,000 different purchase orders were placed by MSVD on subcontractors in 1959.
- More than 25,000 of these MSVD purchases were made from "small" subcontractor businesses.
- More than $26,000,000 worth of goods and services were purchased by these 35,000 orders. This amount represented a major portion of the contract dollars received by MSVD.
- And more than $13,000,000 of this $26,000,000 went to "small" business firms.

If you'd like more information about G.E.'s Missile and Space Vehicle Department . . . its subcontracting activities, its re-entry vehicle programs or about any of its space technology activities . . . write to Section 160-70, G.E. Missile and Space Vehicle Department, 3198 Chestnut Street, Philadelphia 4, Pa.



Mr. Hilliard W. Paige, General Manager, Missile and Space Vehicle Department with Air Force re-entry vehicles developed by MSVD.

1. RVX-2 Re-entry/Recovery Vehicle, the largest ablation-type re-entry vehicle to travel full ICBM-range and be recovered.
2. Flotation balloon used in recovering USAF-MSVD research re-entry vehicles.
3. Recovery equipment package for RVX-2.
4. Satellite Aeromedical Re-entry/Recovery Vehicle for USAF Discoverer Program.
5. Mark-2 recoverable Data Capsule which flew in Thor re-entry vehicle and returned first films from outer space.
6. Mark-3, an advanced operational-type re-entry vehicle for Atlas.
7. RVX-1, first ablation-type re-entry vehicle to be recovered after full ICBM-range flight.
8. Mark-2, first U.S. operational heat-sink re-entry vehicle now in use on USAF Thor and Atlas missiles.
9. Typical ground support equipment developed by MSVD for USAF use. (A) Mark-2 prelaunch check-out console. (B) Mark-3 missile mating equipment.

MISSILE AND SPACE VEHICLE DEPARTMENT

GENERAL ELECTRIC

A Department of the Defense Electronics Division

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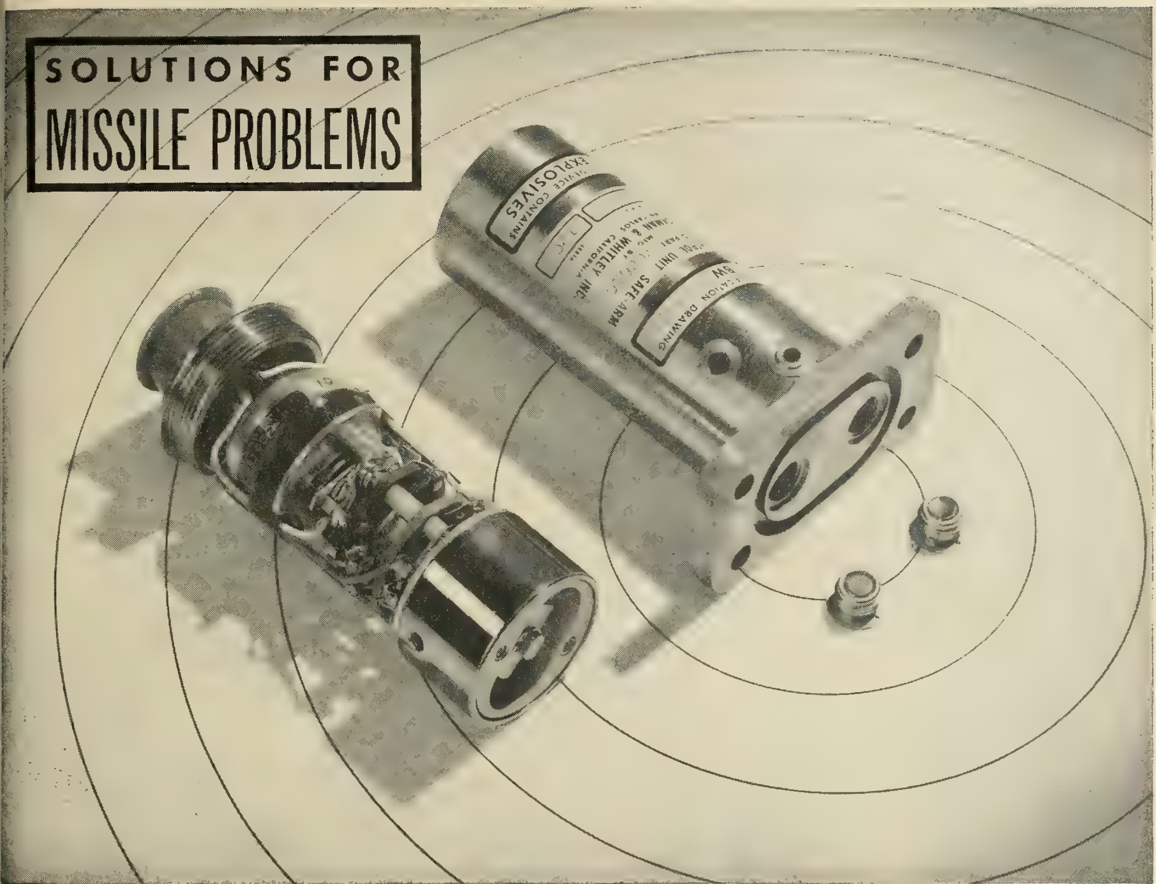

safe/arm initiators

Ten years of pioneering in the missile component field has made possible this new line of Beckman & Whitley solenoid-operated safe/arm explosive initiators. Unit on the left has cover removed to show internal arrangement.

Weighing only 1.85 lb loaded, this model is 5 in. by 3 in. by 1¾ in. It was designed to military requirements. It can be armed or disarmed by remote electrical signal and includes both visual and electrical telemetering facilities for indication of armed or disarmed condition. On reception of a command firing signal, the unit will initiate associated primacord, low-energy detonating cord, (LEDC) or bulk charges.

This may be just what you need. On the other hand, Beckman & Whitley can provide the engineering capability, the production facilities, and perhaps most important, the speed necessary to give you anything you *do* need in the line of propellant-actuated devices.

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Washington Countdown

IN THE PENTAGON

Nike-Hercules improvements . . .
are being sought by the Army to enable the Western Electric missile to be used more effectively against Soviet air-to-surface missiles. The Army claims the *Nike-Hercules* is already capable of downing any Soviet versions of the North American *Hound Dog*.

• • •

Some $44 million . . .
is sought for the *Nike-Hercules* improvement program. The Army also wants an extra $180 million added to its FY 1961 budget for purchase of more *Pershings, Honest Johns, Little Johns, Hawks, Davy Crocketts* and *Redeyes*.

• • •

Another 200 miles . . .
or so can be added to the current 900-mile *Polaris* range simply by removing test equipment from the bird. The equipment is for monitoring the test shots.

• • •

New interservice sniping . . .
is being heard along Pentagon corridors in connection with the *Polaris* program. The latest item: *Polaris* subs may be tailed by groups of Soviet subs from the vast undersea Russian fleet. (A neat trick since *Polaris* subs are much faster than any Soviet diesel-powered sub.)

• • •

Project *Defender* studies . . .
aimed at finding an advanced missile defense system are expected to remain in the study stage during FY 1961. The big ARPA project includes such studies as SPAD—a proposed anti-missile satellite system.

• • •

Transfer of *Transit* . . .
from ARPA to the Navy is still tentatively scheduled for July, but the final word is still to be given. Meantime the second *Transit* navigation R&D satellite is scheduled to be boosted by a *Thor* from Cape Canaveral in March.

• • •

The third BMEWS station . . .
which will be built at Flyingdales Moor in Yorkshire, is not expected to be completed before 1963. The first at Thule, Greenland, is scheduled to go into operation later this year.

ON CAPITOL HILL

The ABMA transfer . . .
from the Army to NASA apparently won't be as cut and dried as some government officials thought. NASA Chief T. Keith Glennan has been forced to openly fight for transfer with the flat claim that his agency is in charge of the nation's entire space program and will need big boosters like *Saturn* long before the Armed Services do.

• • •

The big defense debate . . .
keeps sliding out of focus. The point is not what forces the United States has today, but what the Soviet missile arsenal will be in three years—and what the United States will have to face it.

AT NASA

Political difficulties . . .
are reported to be affecting plans to construct Project *Mercury* tracking stations in Sonora, Mexico, and the Canary Islands. However, NASA denies the report. The two stations are part of an 18-station network that must be ready in 1961.

• • •

The *Saturn* team . . .
is understood to be disappointed that NASA has not allowed for many high-paying super grade positions. Lucrative industry offers are reported to be taking on a greater attraction; some defections are expected.

INTERNATIONAL

The French Navy's *Masurca* . . .
a new solid surface-to-air missile, will soon be installed on several French warships. This *Masurca* is similar in appearance to the Convair *Terrier*.

• • •

***Luniks I* and *II* . . .**
may not have been launched from the Sputnik pads at Kapustin Yar or Aral'sk as previously believed. Some of the latest computations based on radar readings in Finland and Turkey pinpoint the *Lunik* launching pads at Irkutsk on Lake Baikal.

• • •

The first *Blue Streak* . . .
test launching at the Woomera Range in Australia is reported to be imminent. The British IRBM will be hard-based and have a range of some 2000 miles.

THOR
MACE
TITAN
HAWK
ATLAS
SNARK
NIKE B
BOMARC
NIKE ZEUS
SPARROW I
SPARROW II
SPARROW III
NIKE HERCULES
SIDEWINDER
REGULUS II
VANGUARD
REDSTONE
JUPITER C
PERSHING
BULL PUP
MERCURY
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N/D Designs Assembly Savings Into Critical Miniature/Instrument Ball Bearings!

Helping customers *simplify* instrument assembly is a specialty of the N/D engineering group. How? Through *creative* Miniature/Instrument ball bearing application and design. Often, a new ball bearing design will produce assembly savings in excess of its additional costs. Integral ball bearings, too, very often cut down difficult and costly hand assembly of shaft and parts.

A timely example of N/D customer assembly savings can be seen in Nike Ajax and Hercules missile ground support. Here, *special* N/D Instrument ball bearings are now used in precision potentiometers. New Departure engineers recommended eliminating two *single row* instrument bearings, mounted in duplex and requiring precision spacer and separate guide roller. They replaced this assembly with a *special* N/D *double row* high precision instrument ball bearing with integral outer race guide roller . . . and shaft mounted with a nut. This *one* recommendation produced cost savings of over 400%! In turn, the customer was able to reduce the potentiometer selling price to the government. What's more, the New Departure Instrument Ball Bearings improved potentiometer reliability!

You can look to minimum assembly costs and unsurpassed *reliability*. Include an N/D Miniature/Instrument Bearing Specialist in your early design level discussions. For immediate information or assistance, call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

Industry Countdown

MANUFACTURING

France is believed . . .
to have licked the weight problem so that it can fit its new nuclear weapon in an IRBM warhead. The big question: will the U.S. or Britain help France develop an IRBM? France hopes to have IRBM's on operational status by 1967, and would prefer solid-fueled motors. The chances are considered good that the French may now try to speed up the IRBM program by using a de Havilland *Blue Streak* as the first stage and developing their own second stage.

• • •

An $11-million facility . . .
will be built at Hill AFB, Utah, for assembly and repair of Boeing *Minuteman* ICBM's. The new plant—to be designated Air Force Plant 77—is scheduled for completion in 15 months. An A&E to design the plant will be picked within a week.

• • •

Secret Project *Tattletale* . . .
is now under way at Eglin AFB, Fla., using six *Aerobee 300's*. Hughes Aircraft is the contractor for ARDC . . . First *Astrobee 500* will be fired next month from Eglin by ARDC Cambridge Research Center scientists using a rail launcher. Four vehicles are in the program.

• • •

Harvard Business School . . .
has a $265,000 Ford Foundation grant to study the relationships between the government and its weapon system contractors. The study will develop recommendations for changes in either government or business policy and practice and could have a far-reaching affect upon the defense industry.

• • •

Switch from rails to wheels . . .
has been effected in a 350,000-lb., 151-ft. portable missile service structure developed by the Army Corps of Engineers. The tower—believed to be the heaviest thing mounted on pneumatic tires in the country—is electrically driven.

PROPULSION

Over next five years . . .
Douglas Aircraft estimates the government's missile and rocket motor case procurement requirements will run close to $1 billion.

• • •

Requirement forcing contractor . . .
to share facilities cost may snarl the negotiations between the Air Force and Aerojet for a big solid booster. Aerojet is reported to be unhappy over this provision.

ASTRIONICS

Winner of the critical . . .
monitor and control display system for the NASA *Mercury* man-in-space project is the Stromberg-Carlson Division of General Dynamics. Visual display of such data as the astronaut's heart rate, blood pressure, body temperature and the capsule's oxygen pressurization, acceleration rate and route while in orbit will be housed in a 60 x 40-ft. control center at Cape Canaveral.

• • •

Lockheed is looking . . .
for a site in New Jersey to headquarter its New Lockheed Electronics Co.

• • •

***Titan* will be first . . .**
liquid-fueled missile to use complete PCM telemetry system. AC Spark Plug, prime guidance contractor, spent several months evaluating PCM before awarding $2.5-million contract to Radiation Inc. The highly sophisticated airborne package, said to be 10 times more accurate than other systems, will be used with both new and existing ground-based equipment.

WE HEAR THAT

If *Nike-Zeus* Gets . . .
production green light, Douglas Aircraft will do much of the manufacturing at its Charlotte, N.C., Plant . . . Oscar F. Carlson, retired AF brigadier, has left Douglas to become assistant to the general manager of Martin-Denver to aid in management and administration of the *Titan* program . . . The Garrett Corp. has formed a subsidiary in Tokyo—Garrett (Japan) Ltd. . . . Overheard at the magnetohydrodynamics (MHD) symposium in Philadelphia: "The meeting generated much heat, little light, and less power."

Friendly Fluorine Fight

To the Editor:

I would like to make a few comments on the discussion in Jay Holmes' (Propulsion Engineering) column (M/R, Jan. 4), regarding a paper given by Dr. Walter T. Olson of NASA to the American Institute of Chemical Engineers.

His suggestion for the use of fluorine as a hypergolic igniter for the liquid hydrogen-liquid oxygen system will certainly work, as we have been doing this for the past several years in our liquid cyanogen-liquid oxygen system—as explained in my article appearing in your magazine recently (M/R, Dec. 14). However, his suggestion that the fluorine be contained in a separate tank and be gradually cut off as the hydrogen-oxygen combustion is going full blast is needless, since the fluorine can be so placed as to be pushed ahead by the incoming liquid oxygen and, therefore, very little is needed. For example, we use one to two ounces of the liquid for starting our 400-pound-thrust size cyanogen rocket motor.

One cannot escape the feeling that Dr. Olson looks on fluorine with rather a jaundiced eye. He rates the hydrogen-oxygen system as the most promising, and completely ignores the hydrogen-fluorine system. Further, he states that if difficulties are involved in the handling of liquid hydrogen, he foresees the hydrazine-fluorine combination as only a few points behind hydrogen-oxygen in specific impulse. This confuses the picture, so then one must conclude that what he really fears is high chamber temperatures, and this point I had hoped was made clear in my aforementioned article.

Summarizing my friend Ted's timid approach, I would conclude by saying that he is gallantly marching forward exactly in reverse.

William L. Doyle
Director
High Temperature Test Area
Research Institute
Temple University
Elverson, Pa.

Attack on Information Lag

To the Editor:

This in reference to your editorial ("Needed: A Central Materials File") of Nov. 23, 1959.

You have accurately pointed out the prime obstacles to the free and rapid flow of technical information from generation to use. That is, increasing specialization of subject matter, growing complexity of detail, proliferation of fields, proprietary constraints, and publication delays.

However, we believe we have taken a number of steps toward correcting this general defect, at least insofar as defense needs are concerned.

In view of the interest in this subject indicated by your thoughtful editorial, perhaps you would like to comment on our arrangements for meeting this problem.

J. R. Townsend
Special Assistant
Office of the Director of Defense
Research & Engineering
Washington 25, D.C.

Mr. Townsend refers to an experiment tried at Battelle Memorial Institute where a Titanium Metallurgical Laboratory was established for the purpose of:

(a) collecting all useful data, published and unpublished, concerning titanium and possible competitors; (b) visiting persons and companies engaged in work with titanium to exchange data on titanium; (c) doing any laboratory research of small or reconnaissance nature on new ideas or to find quick answers in support of the information function; (d) answering responsible questions on technical matters related to titanium; (e) supplying information on various engineering phases of titanium; (f) issuing occasional papers as a means of directing engineering attention to important but incompletely solved

hases of titanium development.

Mr. Townsend adds that the Deartment of Defense—due to the success f the Battelle titanium work—is preparig to conduct a similar experiment in lastics and reinforced plastics. It sounds ke an excellent idea; presumably Mr. ownsend could give more detailed inormation on request.—Ed.

Pleasure Was Ours

o the Editor:

On behalf of the commander and personnel of Francis E. Warren Air Force ase, I wish to thank you and your staff or the outstanding article ("The New ront—ICBM's Rise on Prairie") in your an. 11 issue.

A special vote of thanks to Jim Baar nd Bill Howard, whose excellent story ividly portrayed the build-up of our base. was as much a pleasure meeting these entlemen as it was reading their story. oth the picture coverage and text were xcellent.

John A. Nydegger
Major, USAF
Staff Information Officer

Cameron Forgings

o the Editor:

We note with considerable interest and ome concern your article in the Feb. 1 ssue. Interest because at Cameron we are vell aware that "Demand for Missile Forgings Grows," as we find that our volume of production forgings going to the missile builders is continually increasing. Concern because Cameron Iron Works was not listed among the "other industry leaders" supplying missile forgings.

An overwhelming percentage of *Nike-Ajax* and *Nike-Hercules* missiles fly today with Cameron one-piece forged booster nozzles. Cameron nozzles are in *Honest John, Little John, Terrier, Hawk,* and many other birds. These forgings have been in production for a number of years. Adapters, closures, heads and spin blanks for these items and numerous other missile forgings are in daily production in our plant.

In the exotic and refractory material field a very significant number of long-range missiles contain Cameron forged unalloyed, arc-cast molybdenum nozzles and Cameron forged 90% tantalum, 10% tungsten throat inserts. Devolopment work is being carried forward investigating other refractory materials.

In addition to the aforementioned missile forgings, nearly all of the gas turbine engines furnishing propulsion for planes and missiles contain Cameron forged shafts, wheels, cases, etc., all produced from high-density and super alloys.

R. D. Springer
Assistant Sales Manager
Special Products Division
Cameron Iron Works, Inc.
P. O. Box 1212
Houston 1, Tex.

M/R's face is red. Cameron's name was dropped inadvertently in writing the final draft of the article. Our apologies to an important supplier of missile/space forgings.—Ed.

Geography Lesson

To the Editor:

We now have Mt. Tranquillon reduced to its proper elevation when—pow! Lockheed's Eagle Mountain test site is placed 80 miles at sea! See page 35, next-to-last paragraph of Lockheed article (M/R, Feb. 8), ". . . heavily-wooded 4000-acre site 90 miles southwest of San Francisco." Obviously gentlemen, you do not have a map of California. Enclosed find a very handy one for your ready reference.

Seriously, I think you have a very fine publication, but just couldn't resist the friendly gibe.

Ken Allen
2426 Benjamin Drive
Mountain View, Calif.

Materials Interest

To the Editor:

We were very much impressed with your Nov. 23 issue (Special Materials Issue). We would like to get several copies of that issue if they are still available.

T. C. DuMond,
American Society for Metals,
Metals Park, Novelty, O.

Copies on the way—Ed.

 Circle No. 9 on Subscriber Service Card.

Lanphier Bows Out at Convair

Criticism of President's defense policies results in forced resignation, but he will continue campaign

By William J. Coughlin

LOS ANGELES—Convair Vice President Thomas G. Lanphier, Jr., was forced to resign from the company last week for his public attacks on President Eisenhower's defense policies.

Lanphier announced his resignation in mid-week after being warned by top officials of General Dynamics Corp., Convair's parent company, to cease his criticism of Administration policies.

General Dynamics President Frank Pace called Lanphier on the carpet within two days after a San Diego press dinner at which the outspoken division vice president attacked President Eisenhower's handling of defense programs.

Lanphier said last week he will continue his campaign against the Administration on a personal basis and on behalf of presidential candidate Senator Stuart Symington (D-Mo.)

• **Blames system**—"I am not leaving voluntarily," Lanphier said. "I am forced to leave by the system—a system which when I speak on matters of national defense finds me factored as a 'Missile Salesman.' Because I am employed in a defense industry and even though I am insistent they are my personal views, I find my observations inferred to carry the endorsement of the organization which employs me."

The Feb. 3 statement to which General Dynamics officials took exception was made at a Convair dinner preceding the first press tour of the *Atlas* production line. Lanphier told visiting newsmen that the President was taking "very dangerous chances" with the nation's survival and added: "I don't think he has that right." He insisted Strategic Air Command should be placed on airborne alert to narrow the defense gap arising from Soviet missile superiority. It was one of the bluntest public attacks ever made on Administration defense policies.

Those present at the dinner included Maj. Gen. O. J. Ritland, Commander of the Air Force's Ballistic Missile Division, and J. V. Naish, President of Convair. Both had been advised in advance of the tenor of the remarks Lanphier intended to make.

Lanphier said he was speaking as an individual, not as a Convair vice president. After his remarks received widespread and not entirely accurate press coverage, Lanphier was called to New York to explain his statements to General Dynamics officials, including Pace.

Rather than be silenced he elected to resign.

• **Reiterations**—"As I understand Democracy, an American who sincerely believes that the nation is in danger must in good conscience say so," Lanphier declared in his resignation statement last Tuesday night. "In this vein, I feel strongly about what I believe to be the Administration's underestimation of the Soviet military for the next three years and I feel equally strong about its concurrent overestimation of the strength and survivability of our own defenses during that same period."

Immediately after announcing his resignation, Lanphier took his case to a nationwide television audience on NBC's Dave Garroway Show on Wednesday morning. There, he hammered again at the President's defense position.

"The father-image is no defense against Khrushchev," he asserted. He repeated his contention that the President is underestimating the military power of the enemy and overestimating that of the United States.

• **Broadens target**—In a private discussion just before his resignation last week, Lanphier extended his attack on the Administration to include Defense Secretary Thomas Gates. He said the defense secretary has not briefed himself adequately for his appearances before Congress.

"Gates goes over there without doing his homework in the most sensitive areas of all," he charged.

Lanphier also declared flatly: "The President is wrong when he says he knows more about modern weapons than anyone else. The evidence is that he does not know. Since his time, modern weaponry has advanced far beyond his comprehension of what it is."

• **Convair regrets**—Convair issued a statement on Tuesday saying that Lanphier's resignation for personal reasons would be effective March 15. President Naish said:

"It is with deep regret, both personal and corporate, that I accept Mr. Lanphier's resignation. During his long association with Convair, he was intimately associated with and made outstanding contributions to successful development of the *Atlas*, F-102, F-106 and B-58 Hustler programs.

"Mr. Lanphier had a distinguished career as an Air Force fighter pilot in World War II. Subsequently, he served as a special assistant for research and development to the Secretary of the Air Force. In recent years he has occupied the presidency of both the Air Force Association and the National Aeronautic Association. This unusual combination of experiences in all phases of air power uniquely qualified him for the responsible assignments he so effectively fulfilled on the Convair team."

From Army Air Corps Ace to Atlas Role

Heavily decorated as an Army Air Corps fighter pilot in World War II Thomas G. Lanphier, Jr., flew more than 100 combat missions in the Pacific and European theaters, shot down seven Japanese planes including one carrying Admiral Yamamoto. During 1949-51, he was successively special assistant to the Secretary of the Air Force for Research and Development; a member of the AF Scientific Advisory Board; and special assistant to Chairman Symington of the National Security Resources Board, representing Symington on the National Security Council's senior staff. He went to Convair in May, '51, as assistant to the President. In November '51, he became Vice President. He has served as president of both the Air Force Association and the National Aeronautic Association.

L.A. Space Show Loses DOD Support

Pentagon raps promoters as implying official backing; A.I.A., Chamber maintained 'hands-off' attitude

The Defense Department has rapped the planned Los Angeles International Air and Space Exposition for "implying" that it has official military backing.

The Department denied that it is supporting the exposition and at least temporarily cancelled plans to set up military exhibits near the site of the show as part of Los Angeles 50th anniversary celebration of the first international air meet in the United States.

The Pentagon acted after it received a series of complaints that the commercial enterprise's agents allegedly were soliciting booth sales on the basis of DOD support.

Earlier, the Aerospace Industries Association issued a denial that it was supporting the exposition. Claims of its support had also allegedly been circulated.

• **'Sniping' charged**—Promoters of the exposition—scheduled to be held at the Los Angeles Sports Arena April 14-24—blamed a "disgruntled ex-employee" for the complaints that led to the Defense Department's action.

Charles H. McLaughlin, Sr., president and general manager of the exposition, said the Los Angeles Chamber of Commerce also has been "sniping" at his project. The Chamber has refused to support the exposition.

A Pentagon spokesman said McLaughlin originally was told that the Armed Forces would not take part in the exposition because it was a profit-making enterprise. Later, the Pentagon agreed to set up displays nearby if they were made open to the public free of admission charge.

• **'Best wishes'**—Now-resigned Deputy Assistant Defense Secretary Chauncey Robbins wrote to McLaughlin Jan. 22:

"This is in further reference to the International Air and Space Exposition to be held in Hollywood, California, on April 14-24, 1960.

"On the basis of the completed questionnaire and additional information you forwarded, a display of Armed Forces exhibits from commands in the vicinity has been authorized at no cost to the government for transportation, maintenance of personnel and operating expenses, provided the exhibits are open to the general public free of charge and are publicized accordingly . . .

"You may be sure that you have our best wishes for a successful Exposition."

The exposition's backers reproduced the letter and distributed it with promotional material soliciting booths.

• **Lifting recommended**—Col. Dean Hess, head of the Armed Forces Information Office in Los Angeles, said complaints received by the Pentagon had led to temporary suspension of military participation, but that after an investigation into the financial situation of the exposition backers he has recommended to Washington that the suspension be lifted.

He said records of the organizers which were made available to him showed no evidence of lack of financial responsibility, although only a few firms from the aircraft and missile field appeared to have signed up for space.

Col. Hess said McLaughlin had agreed to post a cash bond to cover expenses of military participation.

Col. Hess said he understood that as of last week 19 of the 400 exhibit spaces had been sold.

• **Proceeding without Chamber**—McLaughlin said plans for the exhibition were going ahead despite a decision by the prime California aircraft and missile manufacturers not to take part in the show.

"It looks good—we're getting lots of good support," the former hotel and motel man said.

Harold Wright, general manager of the Los Angeles Chamber of Commerce, said the Chamber was not endorsing the exhibition. He said McLaughlin had tried to interest the Chamber in the show and had sought membership.

"We asked for data on who was behind it and evidence to back up his statement that a group of responsible citizens was supporting it," Wright added. He said that the evidence was not submitted.

Mergers and Expansions

Joining other missile/space firms venturing into the European market, H. K. Porter & Cie S.A. makes its second overseas acquisition with the purchase of 51% of the stock of King Aircraft Corp., Ltd., of Glasgow. The Scottish firm specializes in aircraft engine and airframe accessories, including special lines of fasteners, clamps and couplings and flexible metallic hose. It will soon begin production of Porter products.

• **Other important mergers**—Howe Sound Co., of which Sperry Products is a division, announces acquisition of all outstanding stock of Triplett & Barton, Inc. T&B's Burbank, Calif., and Wichita, Kan., laboratories for nondestructive testing will be maintained by Sperry, but its manufacturing operations will be moved to the Sperry plant in Danbury.

Textron Electronics takes a giant step in the field by acquiring GC Electronics of Rockford, Ill., and Schafer Custom Engineering of Burbank, in exchange for 750,000 shares of Textron common stock. GC Electronics' and Schafer's combined sales for 1959 totaled $7,817,000.

Continental Can Co. has sold all its honeycomb facilities to Honeycomb Products, Inc., a new company producing fiberglass and paper products for the aircraft and building industries. All manufacturing rights for the U.S. and Canada to ACF Industries-developed electronic module and capacitor components have been purchased by the Illinois Tool Works, Chicago, for use in radio and television circuitry and defense projects.

In another electronics move, Telex Inc. of St. Paul now owns a 25% interest in Electro-Logic Corp., of California. Ballastran Corp. of Ft. Wayne was purchased by Telex earlier this month.

Applied Dynamics, Inc. is now a subsidiary of Bowmar Instrument Corp., and will operate as an independent company with the same staff. Bentley-Harris Manufacturing Co. of Conshohocken, Pa., has been acquired by Raychem Corp. of Redwood City, Calif.

Sunbeam Corp., well-known in the appliance field, now enters the missile scene through acquiring John Oster Manufacturing Co. The new subsidiary's Avionic Division, producing precision electronic instruments, employs about 1150, 200 of whom are engaged in R&D and engineering.

• **Washington**—Senate Republican leader Everett Dirksen (Ill.), calling upon Democratic defense critics to use "restraint," accused Sen. Stuart Symington (D-Mo.) of not giving all the facts when he rapped the Administration in a Senate speech. Symington replied by calling upon the Administration to clear up the confusion over relative U.S. and Soviet missile strengths by announcing the current ratios. He said this was done last year by Defense Secretary McElroy who estimated that Russia then had a 3-to-1 missile lead.

• **Washington**—Gen. Nathan Twining, Chairman of the Joint Chiefs of Staff, has told Senate investigators he had never seen the estimates of Soviet missile strength given to Congress Jan. 29 by Central Intelligence Agency Director Allan W. Dulles. Twining said he was not aware of the figures when he assured Congress on Feb. 9 that the missile gap had been narrowed. The figures reputedly show the Soviets have more than a 3-to-1 lead in ready-to-launch long-range missiles.

• **Cape Canaveral**—An Air Force *Titan* ICBM passed its second-stage ignition test for the second time Feb. 24. The missile carried a prototype ablative re-entry vehicle containing a data capsule and nose cone which were recovered near Ascension Island, the intended impact area.

• **Washington**—The Eisenhower Administration was charged with delaying more than five months in assigning a DX high priority to NASA's *Mercury* man-in-space program. Rep. B. F. Sisk (D-Calif.) said NASA asked for the priority on Nov. 14, 1958. The request was rejected by the National Space Council Dec. 3, 1958. The priority was again sought six days later on Dec. 9 by the Civilian-Military Liaison Committee and referred to the NSC, which finally granted approval April 27, 1959. According to Sisk, DOD put the priority into effect on May 5, 1959. Sisk made the statement as the House approved President Eisenhower's request for an extra $23 million for NASA, most of it for *Mercury*.

• **Washington**—DOD said the mystery satellite picked up in a polar orbit probably is the ejected recovery capsule of the *Discoverer V* space vehicle launched at Vandenberg AFB last Aug. 13.

• **Seattle**—Lockheed Aircraft is acquiring Colby Steel and Mfg. Inc., Seattle, and Colby Crane and Mfg. Ltd., Vancouver. Both will be operated as wholly-owned subsidiaries.

• **Detroit**—Bendix Aviation Corp. stockholders voted to change the company's name to The Bendix Corp. The change will go into effect about June 1.

• **Farmingdale, N.Y.**—Republic Aviation will announce this week successful operation of its magnetic "pinched plasma" engine continuously for more than 118 hours. One of the first applications of this type of low-thrust engine will be in satellite attitude control. The test, run earlier this month, was terminated to take the engine down for inspection. The engine uses nitrogen for fuel, converting it into a plasma which is pinched by a cylindrical magnetic field and then ejected from the compression chamber at very high velocity. This cycle is repeated continuously at the rate of 30 times per minute. Power required is 3000 volts at 675 watts. The engine was developed by Republic's Plasma Propulsion Laboratory under contracts with the Office of Naval Research and the Air Force's Office of Scientific Research. Republic considers the test successful enough so that it plans to begin designing flyable versions of the engine.

Missile/Space Industry Conference Award Winners

PRINCIPALS AT Dr. Robert H. Goddard Memorial Dinner in Washington recently included, from the left: W. L. Wearly of Joy Manufacturing Co.; AF Capt. Joe E. Jordan who received Joy Aerospace Flight Award; Lt. Gen. Bernard A. Schriever; Mrs. Esther C. Goddard, Karel Jan (Charley) Bossart of Convair, recipient of the Dr. Robert H. Goddard Memorial Trophy presented by Missiles and Rockets Magazine; M/R Executive Editor F. Clarke Newlon; Richard B. Canright of Douglas, winner of Astronautics Engineer Achievement Award; Norman L. Baker, a news letter publisher who presented the award to Mr. Canright; and Delacey Ferris of Reaction Motors who received the Borg-Warner Missile Industry Award from R. F. Schultz.

Norair Proposes Two-Man Orbiting Space Laboratory

A one-week tour of duty for a two-man team operating an orbiting space laboratory is a concept developed by the Northrop Corp.'s Norair Astro Systems and Research Laboratories. The system would be used mainly for measurement and study of the earth's atmospheric phenomena.

The two-man vehicle would orbit at about 500 miles. Its required life support system could supply all needs for a one-week period under normal conditions—two weeks, if an emergency arose. Crews would be ferried to the vehicle by a shuttle system based on a modified *Mercury* capsule and a Norair maneuverability adapter. The actual laboratory platform would be ever-orbiting.

• **Three components**—Three major components would make up the complete system—a mission package and rendezvous/coupling adapter, a life support enclosure, and the shuttle vehicle. The first two units would be placed into orbit as a package and maintained by the shuttle vehicle until the life support enclosure was attached. The final vehicle would make one rotation, in an orbital plane, for each revolution, thus remaining directed towards the earth's center. The occupants could then operate in an essentially free-fall environment. Final-stage boosters would be collected into the vehicle's immediate area and held for further use.

The mission package would contain self-supporting mission equipment. Environment would be such that a man in a full pressure suit (for emergency only) could maintain the mission equipment as required. Special instrumentation for the mission would be modularized and contain its own go-no go test system.

The rendezvous/coupling adapter, second portion of the mission package, would be equipped to handle the shuttle vehicle and couple it to the life support system. Dual air lock provisions would also be available for any manned operations outside the structure. The mission package and rendezvous/coupling adapter would make up a single unit with two sections.

The life support enclosure would contain environmental equipment, communications and monitoring equipment, and off-duty living facilities. The multiple-wall shell would have one end fitted for the mission package and rendezvous/coupling adapter. The other end would have an emergency air lock for access to a standby shuttle; this end would also be a "tie up" point for the new life support enclosure when a replacement crew arrives via the shuttle.

The modified *Mercury* shuttle vehicle could be used either as a cargo or passenger transport. It would carry two men, food, water, oxygen, spare parts and test equipment. Parachutes would be used to recover the shuttle in earth landings. The shuttle would be maneuvered by special motors mounted in the adapter, and directed to orbiting rendezvous by both ground tracking and on-board guidance equipment. Close maneuvering at rendezvous would be aided by optical sights.

TWO-MAN laboratory would require life support system for a one-week period. Crews would be ferried by a modified *Mercury* capsule.

Arcas Launchers Put on Army's Range Ship

Launching facilities for *ARCAS* rockets have been installed aboard the Army Ordnance range ship *USAS American Mariner*. The rockets will be fired to calibrate the ship's precision radars and collect upper-atmospheric meteorological data.

Other additions and modifications have been made to extend the ship's capabilities for tracking, measuring and analyzing the in-flight performance of ballistic missiles. Assigned to the Atlantic Missile Range, the RCA-managed ship is a floating electronics laboratory. Her primary function is the collection of precise data for both offensive and defensive purposes under ARPA's Down-range Anti-missile Measurement Program (DAMP).

The DAMP Contract—administered through the Philadelphia Army Ordnance District—is part of an overall range measurement program. This, in turn, is a phase of ARPA's ballistic missile defense program—Project Defender.

In addition to the tracking radars electronic equipment aboard the ship includes navigation, recording, communication, optical, and precision computing equipment. Some 60 scientists, engineers, and technicians man these facilities.

Data collected on the ship's missions are flown to the RCA data reduction center at Croydon, Pa., for analysis and distribution to 76 government agencies and scientific institutions.

The DAMP ship has been cited as an outstanding example of interservice-industry cooperation. The mission is sponsored by ARPA and administered by the Army. The *ARCAS* rockets are furnished by the Navy. The ship's operating area, the AMR, is managed by the Air Force.

Heteropowered Spacecraft Proposed

SAN DIEGO, CALIF.—Krafft A. Ehricke of the Convair (Astronautics) Division of General Dynamics Corp. has proposed a heteropowered spacecraft of 2.4-million-lb. takeoff thrust which could soft-land 60,000 lb. on the moon or place a 230,000-lb. payload in a 300-nautical-mile earth orbit.

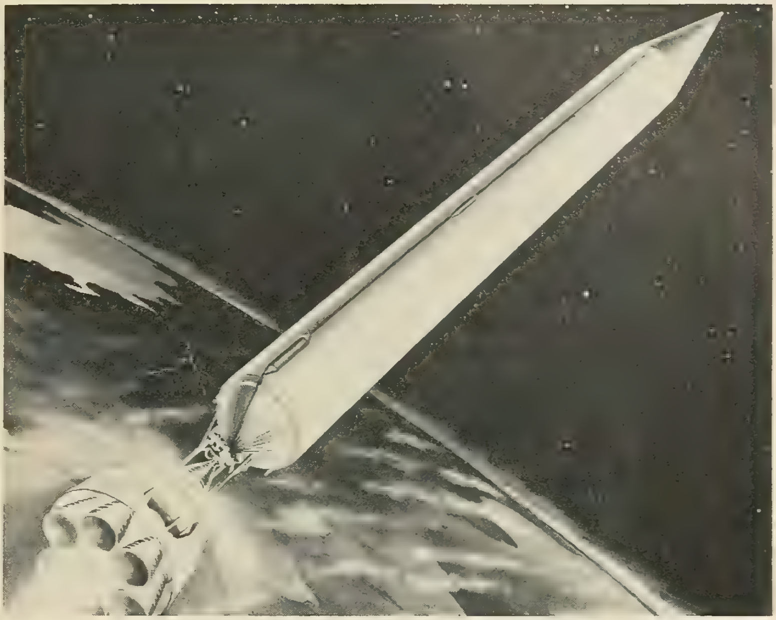
The 1¾-stage vehicle, *Helios II*, would weigh about 1.8-million lb., stand 220 ft. tall and be 32 ft. in diameter. It would be powered by large oxygen-hydrogen engines.

These chemical engines in the Ehricke design proposal are arranged around a 750,000-lb.-thrust nuclear engine. They operate against a thrust structure containing the oxygen tank which, due to its higher density, is much smaller than the main tank containing liquid hydrogen for the chemical as well as the nuclear engines.

To avoid radiation problems arising from running the large nuclear reactor up to full power on the ground, the vehicle takes off on chemical thrust.

The chemical booster serves to lift the nuclear vehicle up to a stratospheric launching level, and is staged above 100,000 ft. altitude as soon as radiation sensitivity of the particular payload permits.

The illustration shows separation of thrust structure, oxygen tank and chemical engines at staging, after the nuclear engine has been phased in.



ARTIST'S CONCEPT of combination chemical and nuclear engine-powered spacecraft which would soft-land 60,000 lbs. on moon.

• **Three jobs**—Three primary types of mission are seen for the spacecraft: orbital assembly of large nuclear interplanetary vehicles, maintenance of lunar establishments, and service as an astronautic coast guard vessel for rescue and other emergency missions.

In addition to soft-landing large payloads on the moon, it also is capable of placing about 78,000 lb. into a satellite orbit around Mars.

Ehricke says a vehicle of this type is feasible in the early 1970's—if the development of nuclear heat exchanger engines is pushed vigorously in the next 10 years.

Hawk Motor Fires After An Eight-hour Dunking

A solid-propelled Army *Hawk* motor was fired successfully in a recent test after being immersed in water for eight hours.

The test was conducted at the Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala. The motor, manufactured by Aerojet-General, was immersed in four feet of water at 70°F for eight hours and then withdrawn and inspected for leakage. The propellant was still dry.

Then the weather seal was broken and the motor was placed back in the water. It was drained without drying and stored at 0°F for 48 hours. A thin coating of ice formed on the propellant bore and the igniter basket. Nevertheless, the motor was fired successfully.

The tests were part of the Raytheon *Hawk* qualification program now in progress at ARGMA.

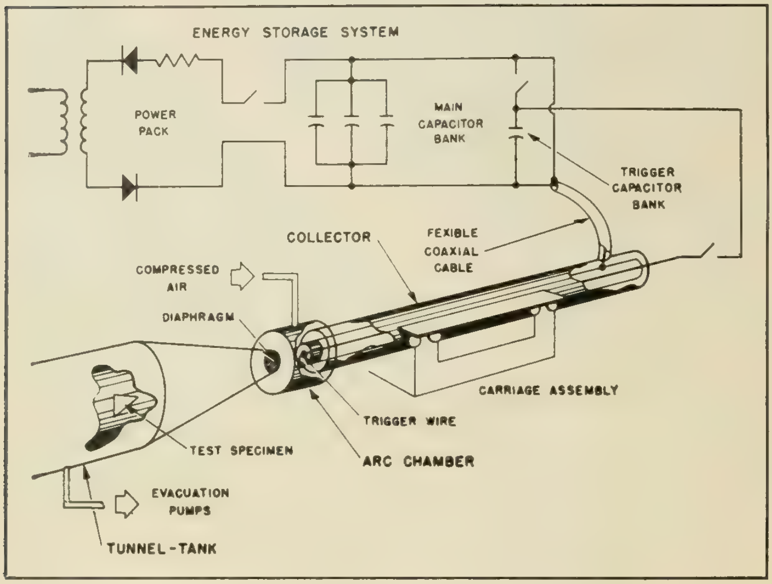
'Unconventional' Power Sources to Be Discussed

A special forum at the National Power Conference to be held in Chicago, March 29-31 will feature discussion of unconventional methods of power generation. Both direct and indirect energy conversion methods will be described.

Subject and speakers include "Magnetohydrodynamic Power," Dr. Arthur Kantrowitz, Avco Corp.; "Isotopic Heat and Power," W. W. T. Crane, Martin Co.; "AF Nuclear Rocket Program," Lt. Col. H. R. Schmidt, USAF; and "Fuel Cells," E. Gorin, Pittsburg Coal Co., Div. of Consolidation Coal Corp.

The three-day meeting will be primarily concerned with more prosaic methods of generating power. Some 90 papers will discuss all aspects of the power industry. The conference is sponsored by Illinois Institute of Technology. Further information is available from the Director, American Power Conference, IIT, Technology Center, Chicago 16, Illinois.

Hypervelocity Wind Tunnel Planned at McDonnell



TUNNEL WOULD test missiles components at altitudes to 100,000 ft.

A new "hotshot" hypervelocity impulse wind tunnel—providing test velocities of 9 to 24 times the speed of sound—will be installed by McDonnell Aircraft Co., St. Louis. It will be used to investigate thermal and aerodynamic properties of missiles and aircraft at hypersonic speeds and altitudes above 100,000 feet.

The system is composed of four basic sections: expansion cone/test section, vacuum reservoir, arc chamber, and energy storage system.

Prior to test, the arc chamber is filled with highly compressed air and the tunnel-tank evacuated to a pressure of one micron of mercury. Electric power from the energy storage system is delivered to the arc chamber, increasing the pressure and temperature of the air in the chamber up to 100,000 psi and approximately 14,000°F. The thin diaphragm separating the arc chamber from the tunnel-tank is vaporized by the high temperature. The high-pressure air expands through a tungsten throat to hypersonic velocities in the test section.

The energy storage system—ordered from Westinghouse Electric Corp.—can deliver electrical power at the average rate of 2 1/3 million kilowatts—more than six times the rating of the largest turbine-generator.

The McDonnell wind tunnel will be able to run an 0.08-second test every 15 minutes. When completed, it will have a 50-in. and a 30-in. diameter test section. Provisions have been incorporated for future expansion to a stored energy level of ten megajoules.

High Potential Seen for Nitronium Perchlorate

Callery Chemical Co. reports that nitronium perchlorate (NO_2ClO_4) shows potential of replacing ammonium perchlorate in some solid-propellant applications.

A high-density, energetic solid oxidizer, it may also offer attractive advantages in hybrid rocket systems, Callery said recently. It is now being made available in research quantities for experimentation by propellant manufacturers, with the expectation that large-scale production will follow.

In a technical bulletin, Callery said nitronium perchlorate has a heat of formation of 8±0.4 Kcal/mole. A white crystalline powder of particles one to five microns in diameter, it has a density of 2.25 g/cc and bulk density of 0.4 g/cc.

Shock sensitivity is low, according to Callery. The pure material did not detonate at 250 KG-cm impact. Impure material may be shock-sensitive. It does not melt; instead, it decomposes rapidly without explosion in the temperature range 250°-285° F.

It is extremely hygroscopic, reacting irreversibly with water to form a mixture of nitric and perchloric acids. It reacts with most organic materials and reducing agents.

High-strength Cobalt Steel Made by Universal-Cyclops

A new high-strength steel developed specifically for missile motor cases has been produced by Universal-Cyclops Steel Corp., Bridgeville, Pa.

Designated Unimach UCX2, the steel differs from the AISI 4100 series metals in that 1% cobalt has been added as an alloying element. When properly tempered to the 225,000-235,000 psi levels, the alloy shows essentially no susceptibility to notch sensitivity.

C. C. English, Manager of High-Temperature Sales, said that the alloy has excellent forming characteristics and good weldability; he predicted that production costs would be reduced accordingly.

High-Temperature Plastics Study Begins at Taylor

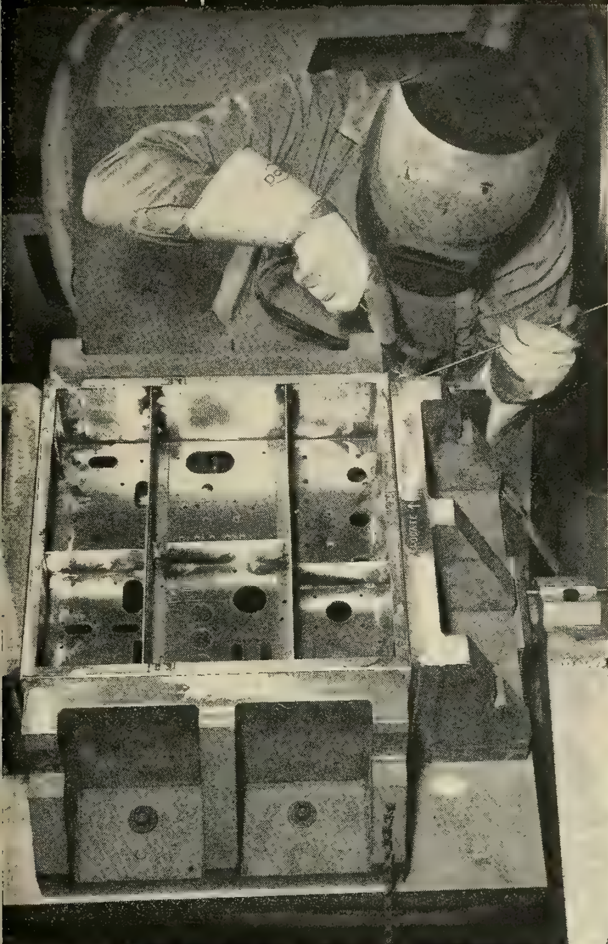
Superior plastic laminates for nose cones and throat nozzles are expected to result from a new research effort by Taylor Fibre Co., Norristown, Pa.

Dr. Carlisle M. Thacker, Technical Division Director, said the high-temperature erosion and high thermal insulation qualities of a wide variety of plastic materials will be studied.

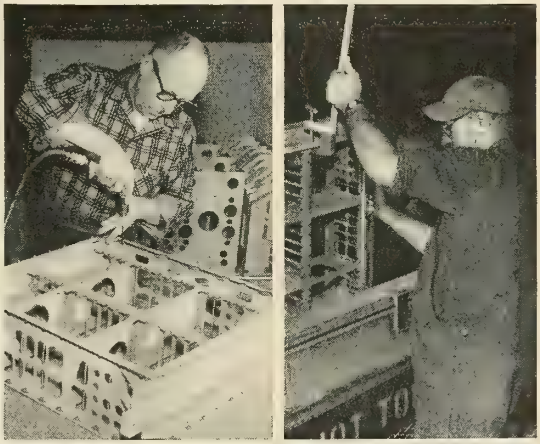
Web and resin combinations will include paper, asbestos, nylon, Dacron, Orlon, Refrasil, graphite cloth and Teflon in laminates with many resins.

The qualities which influence missile applications are low heat conductivity; steady, slow evolution of low molecular weight gases on decomposition; high heat absorption from physical transitions and retained high structural

DOW *Now in magnesium and aluminum*



DRAWING. This gyro cover is drawn in a single operation. It replaces a part which consisted of welded components.



WELDING. Heliarc welding joins parts of this control central case. Dow facilities and personnel for welding are government certified.

ASSEMBLY of this 4-deck housing with rivets, bolts and welds precedes FINISHING with Dow Number 17 anodic treatment.

DOW FABRICATION PLANT SAVES WEIGHT, TIME, COSTS ON ICBM COMPUTER HOUSINGS

Working closely with the customer, Dow engineers suggested design modifications for a three-deck computer housing that yielded improvements in both production and application.

Over-all production costs were lowered 20%-30%, compared to the original design. Per-unit tooling costs were also lowered. The new design resulted in better load distribution and increased interchangeability of parts. Delivery schedules were speeded.

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For more information contact your Dow Sales Office or write today for illustrated brochure describing Dow fabrication facilities and services. THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Dept. 1040CL2-29.

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strength after surface charring.

Thacker said several of the currently successful laminates were the result of an accident—they were initially designed for electrical applications. A research program based on missile needs should provide superior materials.

International Minerals Cuts Magnesium Dioxide Prices

A reduction in the price of low-boron magnesium dioxide, in all shipping categories, has been announced by International Minerals & Chemical Corp., at its Carlsbad, N.M., plant.

The new prices are $155 per ton in bulk and $160 per ton in bagged carloads, 30 tons minimum. This is down from $235 bulk and $240 bagged per ton.

The low-boron magnesium dioxide is used in nuclear reactors and research and is being evaluated for use in capacitors and missile nose cone coatings by the Air Force.

Polymers Obtained from Cotton Fiber Furfural

Moscow—A group of specialists at the Institute of Chemistry, Uzbek Academy of Sciences, under the direction of Candidate of Chemical Sciences A. Sultanov, has reportedly developed a method for obtaining new polymers—polyfurans and polysylvans—by means of the polymerization of furan and sylvan, extractable from the furfural of cotton fiber.

The Soviets claim the new polymers to be good film producers, and say they can be used by the cable industry in making glues for thermostable and bacteriostable coatings, and as solvents of polymeric materials.

The Fergana Hydrolysis Plant is said to be producing polysylvans. *(Vestnik Akademii nauk SSSR,* No. 11, 1959, p. 73)

Douglas Develops Plastic-Fiber Glass *Zeus* Nozzles

Fiber glass and plastic nozzles have been developed for the *Nike-Zeus* anti-missile missile, Douglas Aircraft Corp. reports.

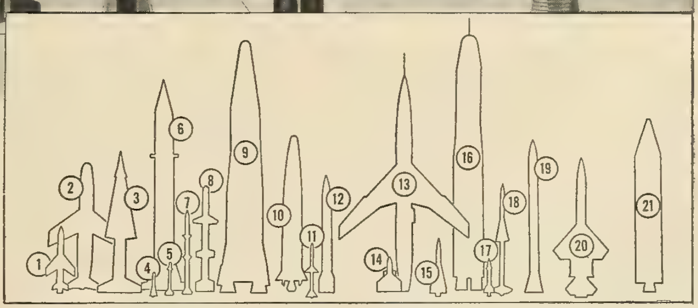
Douglas said the booster nozzle is the largest plastic rocket-motor nozzle built in this country. Nozzles on both booster and sustainer engines are made of the high-temperature-resistant fiber glass and plastic composition.

N. H. Sharpell, works manager of Douglas' Santa Monica division, announced that missile nozzle research and production activities are being shifted to an area of 50,000 sq. ft., tripling the space allotted to the expanding program. He said additional fabricating equipment is being installed. The new area also includes a section for research and development production of experimental nozzles.

Bags Used for Mace Landings

RUBBER-COATED fabric air bags fastened to the *Mace* missile are used as landing gear for recovery of the vehicle. Manufactured by Goodyear Tire, the recovery bags fit around the *Mace's* belly when popped into shape by compressed air during landing.


USA
ATLAS
US
ARMY
THOR
USAF



1. **Lacrosse.** Army. Ground-to-ground. Prime contractor: Martin.
2. **Mace.** Air Force. Ground-to-ground. Prime contractor: Martin.
3. **Nike Hercules.** Army. Ground-to-air. Prime contractor: Western Electric.
4. **Falcon.** Air Force. Air-to-air. Prime contractor: Hughes.
5. **Sidewinder (GAR-8).** Navy/Air Force. Air-to-air. Prime contractors: Philco; General Electric.
6. **Redstone.** Army. Ground-to-ground. Prime contractor: Chrysler Corp.
7. **Terrier.** Navy. Surface-to-air. Prime contractor: Convair.
8. **Talos.** Navy. Surface-to-air. Prime contractor: Bendix Aviation.
9. **Atlas.** Air Force. Ground-to-ground. Prime contractor: Convair.
10. **Thor.** Air Force. Ground-to-ground. Prime contractor: Douglas.
11. **Sparrow III.** Navy. Air-to-air. Prime contractor: Raytheon.
12. **Sergeant.** Army. Ground-to-ground. Prime contractor: Sperry Rand.
13. **Snark.** Air Force. Ground-to-ground. Prime contractor: Northrop.
14. **Quail.** Air Force. Air-to-ground. Prime contractor: McDonnell.
15. **Hawk.** Army. Ground-to-air. Prime contractor: Raytheon.
16. **Titan.** Air Force. Ground-to-ground. Prime contractor: Martin.
17. **Bullpup.** Navy. Air-to-ground. Prime contractor: Martin.
18. **Nike Ajax.** Army. Ground-to-air. Prime contractor: Western Electric.
19. **Corporal.** Army. Ground-to-ground. Prime contractors: Firestone; Gilfillan.
20. **Bomarc.** Air Force. Ground-to-air. Prime contractor: Boeing.
21. **Jupiter.** Army. Ground-to-ground. Prime contractor. Chrysler Corp.

British Renew Row over Launch Systems

Navy wants Polaris submarines; RAF favors aircraft launchers—debate affects U.S. sales hopes

by an M/R Correspondent

LONDON—Great Britain's 1960-61 defence budget has touched off another row among top-level authorities on whether nuclear deterrent missiles should be land-, sea-, or air-based.

The outcome could vitally effect U.S. industry's plans for selling *Polaris* FBM submarine missiles and the *Skybolt* air-launched ballistic missile.

On one side, the Royal Navy is in favour of creating a force of three or four nuclear-powered submarines, each equipped with 16 *Polaris* missiles and each with two crews. However, the value of *Polaris*-firing subs has been seriously questioned in Britain because of cost and probability of detection by an enemy. Britain plans construction of two nuclear submarines. One would employ U.S. know-how, but the second would be an all-British design. Both, however, are intended for antisubmarine work and not for firing ballistic missiles.

On the other side, the Royal Air Force argues that ballistic missiles should be fired from VTO aircraft or another type of plane capable of getting into the air rapidly. The argument advanced in favour of this system is that the aircraft could also be used for other purposes, whereas submarines have little use except in total war.

Britain's most advanced long-range missile is the de Havilland *Blue Streak*, designed to be launched from concrete pits, which the Navy and the RAF claim are too vulnerable. Experience with *Thor* missiles now in Britain has shown that it is impossible to keep the locations of the launching sites secret. Accuracy apparently achieved in the recent tests of Soviet missiles in the Pacific show that it would be quite easy to knock out all the possible launching sites in Britain.

• **Point of no return**—The interservice dispute has been in existence for many months but the development of *Blue Streak* has proceeded so far that it would now be just as expensive to cancel the project as to complete it. Moreover, cancellation would be a heavy blow to the morale of scientists and engineers throughout the British missile industry.

The Government White Paper, "Report on Defence 1960," states that "the development of the British ballistic missile *Blue Streak* is continuing. However, it may be decided not to rely exclusively on fixed-site missiles as the successor to the medium bomber armed with the stand-off powered bomb. Therefore the possibilities of mobile launchers, whether aircraft or submarines, for long-range delivery of nuclear warheads are being investigated."

If it is decided to go over to mobile launchers, *Blue Streak* will still have a future as a satellite booster. Although no official statement on this has been made, it is understood that preliminary work on this has gone beyond the stage of just examining possibilities, and more detailed design studies are in progress.

The easy solution to the launching dispute would be to go ahead with all three possibilities, but this would involve increased expenditure. The estimated cost of defence for 1960-61 ($600 million) is apparently $322 million up on that for 1959-60, but this is partly a bookkeeping transaction—the real increase is about $250 million.

Russian Space Suit Is Described in German Paper

A new Soviet space suit, recently described in a German newspaper, is tailored to the wearer and made of insulating foam material. Its oxygen apparatus is located under a bulge of the same material and is an integral part of the suit.

There are 12 pockets containing the technical equipment: a built-in automatic telephone for short-distance communication; a radiation-measuring device, the buzzer of which is connected to the wearer's ear; a searchlight with a permanent-type battery; emergency food and drugs; a pocket-size transmitter; a new lightweight pistol with two magazines, one with regular ammunition, the other with flare cartridges; and other tools and instruments.

The article also notes that in case of emergency, a valve blocks the oxygen supply for 20 seconds. (*Der Mittag*, Dusseldorf, Jan. 8, p. 3.

Astronomer Sets Age of Wrinkles on the Moon

In a recent Soviet bulletin, K. A. Lyubarskiy discussed his method of estimating the age of the wrinkles on the moon, presupposing both meteoritic and volcanic lunar landforms.

The larger lunar seas and craters with an average diameter of 20-30 km are, according to Lyubarskiy, largely of volcanic origin, while the smaller disfigurations, or pockmarks, with diameters of about 6 or 7 km, are, for the most part, of meteoritic origin.

Knowing the velocity and mass distribution of the smaller craters, it is possible, the author argues, to compute the number of meteoritic bodies falling on a given area (ikm ^{2}) of the moon in a given time period (1 year) and thus estimate the age of the area or formation involved.

The author used Mare Tranquilitatis and Mare Humorum for his experiment; he estimates that the former is between 2 and 46 million years old and the latter between 4 and 94 million years. In terms of geological events on earth, this would correspond to the period of Alpine mountain building, or the Upper Cretaceous and beginning of the Tertiary. (*Byulleten' Vsesoyuznogo astronomo-geodezicheskogo obshchestva,* No. 25 (32) 1959, p. 3-8.)

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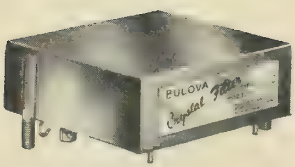

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Astronauts Will Require Less Sleep

Air Force documents needs during extended immersion in water for weightlessness

by Don Zylstra

Weightlessness poses real hazards for the first astronaut in terms of muscular and skeletal deterioration. But even more remarkable will be his reduced sleep requirements, documented for the first time this month by researchers in space medicine.

Less than seven hours of fitful sleep in a week was all a 28-year-old Air Force physician was able to manage during his long session in a Space Age bathtub at the Air Force Aerospace Medical Center at Brooks Air Force Base, Tex.

Nobody deprived Capt. Duane E. Graveline of his sleep. He was encouraged to doze off whenever he could. But seven hours out of 168 was all he seemed to need. His surprising wakefulness was recorded during his prolonged immersion in water in a test to simulate weightlessness.

Space physicians have already ordered a new version of the familiar steamer chair—a couch with built-in springs, making it tend to fold upward, pushing against the body of the astronaut. His muscles and skeleton, pressing against the spring pressure, would supply continuous "exercise" and the muscle tone that is lost during periods of complete inactivity and weightlessness. Doctors hope the device will reduce muscular weakness and changes in bone structure.

Clad in a water-tight, skindiver's rubber suit, Dr. Graveline spent seven days supported by the 400 gallons of warm water in his tub. During this time his bodily movements were restricted, corresponding with conditions the first astronauts will experience in their cramped space capsules.

• **No real sleep**—Space scientists expected many changes in his heartbeat and circulation. But his reduced sleep requirements came as something of a surprise. Even during the few hours he did doze, his "sleep" was far from sound.

Electroencephalograms of his brain were like those of normal adults just dropping off to sleep or beginning to awaken. Only twice during his buoyant seven days did the doctor record anything that resembled sound sleep and then only for three to five minutes at a time.

"Results of Dr. Graveline's seven-day immersion may have far-reaching influence on medical theories about the causes of sleep in humans," Dr. Hubertus Strughold, research advisor at the Aerospace Medical Center, said. "Greatly reduced muscular activity, accompanied by a corresponding diminished sleep requirement, is prompting a new look at all our concepts of sleep. This test also confirms our belief that much more research is needed before we can describe even 'normal' human behavior accurately."

• **Theories affected**—Both Drs. Strughold and Graveline noted that the weightlessness experiment would cast "interesting new light" on widely held medical theories about the nature of sleep. Much of the early test data would seem to support the "metabolic" theory—that sleep is induced by the by-products of normal metabolism in the human system. A reduced metabolic rate with drastically restricted exercise may have lessened Dr. Graveline's sleep needs.

The "kinesthetic-feedback" theory, also widely held, may also derive some support from the experiment, Dr. Graveline said. According to the kinesthetic theory, a decrease in the sensory input to the sleep-regulating area of the brain lessens the "feedback" along motor nerve paths, promoting sleep. The sleep center of the brain also apparently acts to "coordinate" sleep, promoting rest for all areas of the human system at the same time. Doctors studying results of the bathtub experiment agreed that it is "too early to draw many conclusions" from this first attempt.

Long periods of uninterrupted wakefulness on the part of astronauts may come as an unexpected bonus in planning space flight routines. But medical researchers agreed that "many of the elements" of true space flight were missing in their tank test.

Dr. Graveline, despite his lack of exercise, wasn't subjected to many of the sensory deprivations endured in other human experiments in space capsules. As a result, he was free from the hallucinations experienced by some astronauts in other tests.

• **Sit-ups in orbit?**—"Unless space pilots can exercise regularly, or are provided with conditions resembling gravity, they may be unable to handle essential tasks on re-entering the atmosphere in their space vehicles," Dr. Graveline said.

"My seven days in the tank indi-

SEVEN HOURS sleep out of 168 was all that was needed by Air Force Capt. Duane E. Graveline during tests at Brooks Air Force Base.

cated I might have found the judgments and manual tasks demanded by re-entry virtually impossible."

Aerospace doctors noted significant deterioration in Dr. Graveline's muscles and bones. During an hour outside the tank daily to change his long underwear and his rubber suit, his skin turned blue, his pulse rate skyrocketed and his blood pressure was described as "critically low."

"During the last few days of the experiment it was actually a relief to get back into the water," Dr. Graveline said. "I became weaker each day.

"It was even difficult to muster enough energy to talk unless I was in the tank. I was unusually sensitive to changes in temperature. The water was kept at a steady 91.4°F. Even a degree higher or lower felt too hot or too cold."

• **General tearing-down**—"Daily examinations showed my muscles were getting softer and smaller. Calcium and phosphorus leaving the bones appeared in increasing quantities in the urine, subjecting the kidneys to abnormal elimination conditions."

Because his anti-gravity muscles and his bones no longer had work to perform, they were literally tearing themselves down. Although no significant weight loss accompanied these changes, he noted marked differences in his joints.

"During the test and for several days after leaving the tank, I noted an unaccustomed, loose-jointed feeling," Dr. Graveline said. "It was as if the ligaments had relaxed for want of something to do."

Certain sensations of the weightlessness of space flight are duplicated when a human body floats in water. While other organs and body functions continue to react to earth's gravity, bones and muscles respond to inactivity much as they would in weightless flight. Normal reactions of anti-gravity muscles, almost as subconscious as breathing, are no longer needed.

During his seven-day immersion, Dr. Graveline was supported only at the back of his head, and secured by his ankles. Only his head was above the water surface. Body movement was reduced to motion of his forearms through the limited arc needed to operate levers under his hands on the floor of the water-filled tank.

The levers enabled him to register his responses to work problems flashed before his eyes on an electronic panel.

• **Food for floating**—Brooks medical center researchers put Dr. Graveline on a special liquid diet for four weeks preceding the immersion test.

Frequent checks on Graveline's metabolic rate during the pre-tank period assured an adequate balance of food intake to his energy requirements.

Both volume and thickness increases and a higher red corpuscle count were noted in Dr. Graveline's blood during the experiment. But medical researchers were reluctant to attribute them directly to simulated weightlessness. They emphasized that better controls would produce more accurate data in this area.

Early inferences from the test indicate that astronauts will experience few bodily changes from a four or five-hour journey in space. But after 24 or 48 hours there will be "significant" reactions. Planning is already in progress to counteract them.

• **Waltz me around again**—After Dr. Graveline's waterborne experiment, he was flown north for a punishing session on the centrifuge at Wright-Patterson Air Force Base, Ohio. Before his week of enforced inactivity, the young medic had "blacked out" when extra forces pressing on his body reached 4.9 g.

Dr. Graveline climbed shakily from his tank, dressed in a flight suit, and was helped into the cockpit of an F-100 jet whose pilot whisked him from Brooks AFB to Wright-Patterson.

"My blood pressure had fallen to a critically low figure and was hardly measurable with conventional instruments. My pulse didn't drop below 150 for the entire flight," Dr. Graveline said. "Normally it's in the eighties.

"The centrifuge session was much harder to endure this time. I was giddy, my pulse went even higher and I was violently nauseated. But evidently my body was still able to provide sufficient blood circulation to nourish my brain and eyes. The g-forces climbed right up to 5 again before I blacked out."

Anyone for Tennis?

THIS 20-LB., 30'-diameter "balloonite" will be shot into a 1000-mile orbit sometime during the spring. Manufactured by G. T. Schjeldahl Co., it will carried in two small hemispheres, pictured near the young lady's feet, on a *Transit* vehicle.

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M/R ANNUAL ASTRIONICS REPORT

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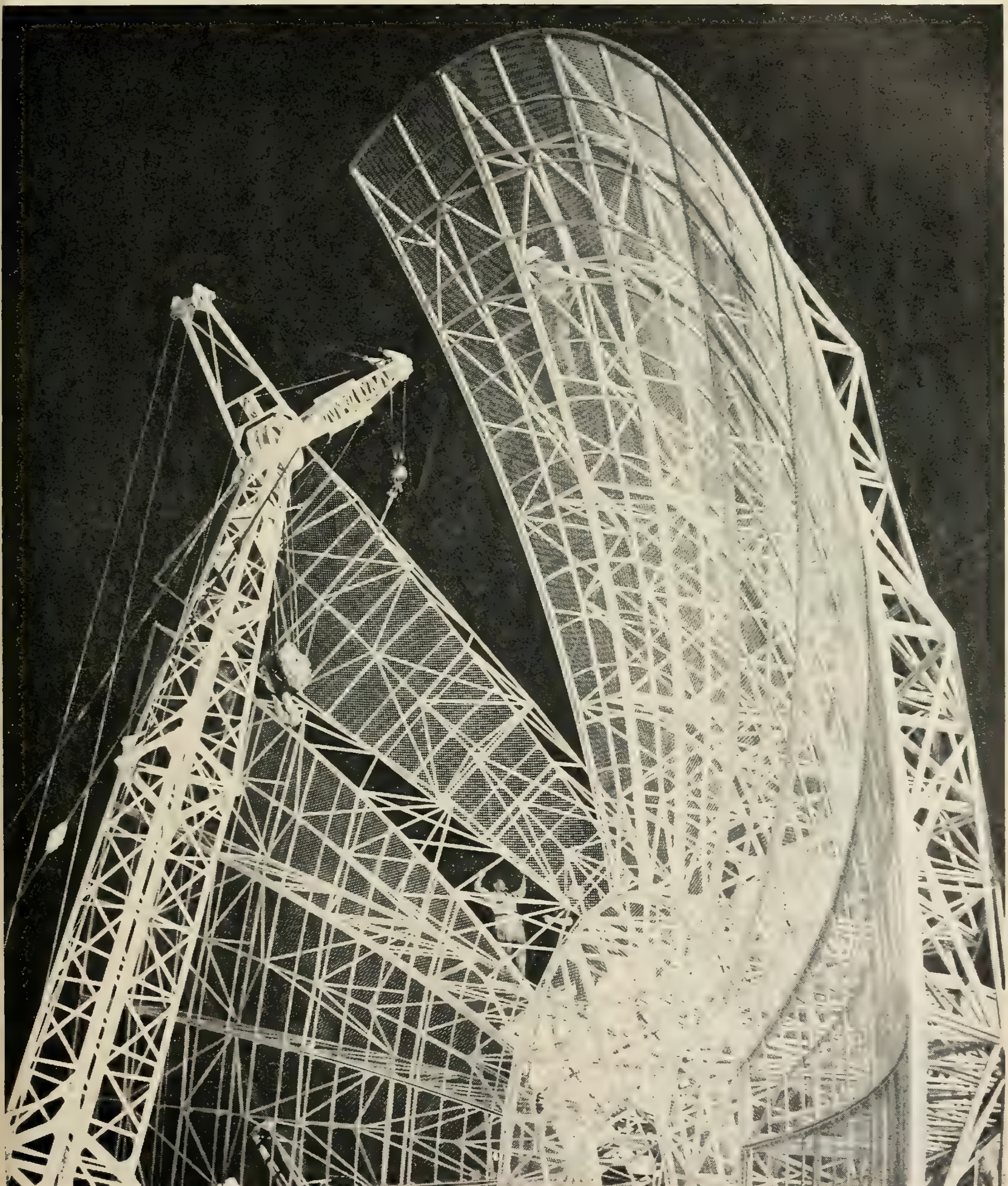


Goodyear's BMEWS Radar Tracking Antenna (see p. 56)

Boom Year Seen for Electronics

Market analysis shows rising sales and strenuous competition—increasing R&D costs are squeezing the smaller companies

by M/R Staff

Pushed hard by missiles, control, communications and warning systems, the military electronics market today is on the way to another record year. Expected 1960 sales: $5.2 billion.

Market analysts brimming with freshly digested figures from the FY 1961 defense budget are predicting an exuberantly rising sales curve through 1968. There isn't a dip or a plateau in sight.

Hand in hand with the spectacular increase in sales, they believe, will come an almost complete displacement of tubes by transistors. Where transistorized equipment will account for $1.560 billion, or 30% of the $5.2-billion military market this year, the Electronic Industries Association is forecasting the percentage will rise to 85% in 1968—$8.67 billion out of the $10.2 billion total.

This bodes well, of course, for manufacturers of transistors and related semiconductor devices. Or at least for some of them, as industry experts see it.

The dramatic increase in demand is almost certain to accelerate the current move toward large-scale, automated production lines. And this could bring about a drastic reduction in the number of transistor manufacturers. There are 42 today. But a "shakeout" could cut their ranks to four or five large producers in the next few years, it is believed.

Backing up this opinion is an Electronics Production Resources Agency report which shows a military requirement through 1961 for 38 million transistors. Fully 29.5 million of this number will be made from 30 basic transistor types now manufactured by seven of the major firms.

Ever-increasing R&D costs, accompanied by a chronic shortage of top-grade scientists, also are expected to put the squeeze on smaller companies lacking the financial resources to remain competitive.

There appears to be, however, practically no limit to opportunities for the designers and packagers of specialized equipment.

• **Major market factors**—The Air Force will be using huge amounts of equipment well into the decade, to back up its presently planned 27 squadrons of *Atlas* and *Titan* ICBM's and the follow-on installations for *Minuteman*. Electronic gear required by missiles of all types now averages from 40% to 45% of their total cost.

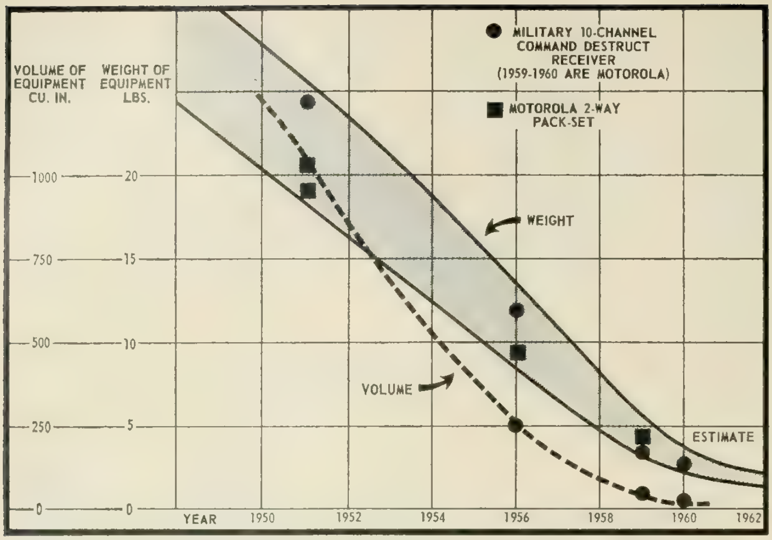
Prospects for the AF's air-launched ballistic missile—*Sky Bolt*—are still bright. This weapon could create a major demand for lightweight and miniaturized checkout, guidance and fire control gear that can be packed aboard an aircraft.

Another new market area about to open wide is the Air Force's *Midas*

How Electronics Figure in Defense Budget

	New Obligational Authority			Direct Obligations			Expenditures		
	FY 1959	FY 1960	FY 1961	FY 1959	FY 1960	FY 1961	FY 1959	FY 1960	FY 1961
Total Procurement	14,293	13,090	13,085	14,800	13,605	14,364	14,410	13,943	13,602
Army	1,249	1,379	1,337	1,097	1,388	1,524	1,388	1,251	1,198
Navy	4,557	3,851	4,673	4,757	4,240	4,697	4,464	4,322	4,355
Air Force	8,487	7,860	7,075	8,945	7,977	8,143	8,554	8,369	8,049
OSD	—	—	—	1	—	—	3	1	*
Aircraft	6,134	6,143	4,753	7,004	5,940	6,013	7,658	6,670	6,027
Army	64	119	119	54	117	136	113	108	132
Navy	1,649	1,739	1,640	1,820	1,646	1,875	2,152	1,683	1,663
Air Force	4,421	4,285	2,994	5,130	4,176	4,002	5,393	4,879	4,232
Missiles	4,107	3,244	3,825	3,702	3,540	3,805	3,339	3,500	3,479
Army	642	399	351	555	400	401	725	472	413
Navy	543	379	450	540	469	464	319	389	397
Air Force	2,923	2,466	3,024	2,607	2,671	2,941	2,295	2,639	2,669
Ships	1,947	1,139	2,035	1,846	1,500	1,740	1,493	1,651	1,644
Army	4	4	3	4	4	4	2	3	4
Navy	1,943	1,135	2,032	1,841	1,496	1,736	1,488	1,647	1,640
OSD	—	—	—	1	—	—	3	1	*
Ordnance, vehicles, etc.	491	836	870	484	818	1,023	476	600	691
Army	226	545	586	200	539	668	188	355	380
Navy	136	146	133	164	155	200	176	177	185
Air Force	129	145	151	120	125	155	113	68	125
Electronics & Communications	1,074	1,276	1,088	888	1,330	1,244	942	898	1,067
Army	121	151	148	111	169	169	185	156	140
Navy	100	315	179	184	318	183	153	196	160
Air Force	854	811	761	594	843	893	604	546	766
Other	540	451	513	877	476	539	502	623	739
Army	193	160	129	173	158	147	175	178	175
Navy	186	136	239	209	156	239	177	229	308
Air Force	161	154	145	495	162	153	150	236	256

*Less than $500 thousand



REDUCTION OF equipment size is not just a trend, it's big business. Fund outlays soon will make microminiaturization $1 billion industry.

early warning satellite program and *Samos*—the reconnaissance satellite. Each of these programs would use about a dozen satellites in space and perhaps 10 to 20 new tracking and reporting stations.

The AF has told M/R that these two systems would require completely independent facilities. As one official put it:

"There would be no point in having a *Midas* satellite if there was any chance that at the moment it detected an enemy ICBM headed for Chicago, its communications channel was preempted by the report from a recon satellite about a string of barges moving down the Volga."

A total of $95 million in AF R&D funds is earmarked for *Midas* and *Discoverer,* the early recon satellite. Another $221 million will be used for research, development, test and evaluation of *Samos* and *Sky Bolt.* The exact breakdown between the latter two strategic weapons has not been revealed.

Modernization of Strategic Air Command communications and continued funding of BMEWS and air defense alert systems is reflected in projected FY 1961 expenditures of $1.067 billion for electronics and communications. This is $169 million more than in the current fiscal year.

The Army is still stumping hard for its *Nike-Zeus* antimissile missile, which would require a vast amount of highly selective acquisition and tracking radar. While the chances appear rather remote that *Nike-Zeus* ever will go into full production, the Army nevertheless is spending more than $324 million in FY 1961. The total invested in the program so far is running to $760 million. But, significantly, the Army feels that regardless of whether test objectives are met, the investment will pay off in the electronics area.

Look for a step-up in the Navy's *Polaris* fleet ballistic missile submarine program. Twelve subs are programmed now. But once the first sub—the George Washington—is proved out this year, the chances are good for an acceleration in the 1962 budget, or possibly in a supplemental budget to FY 1961.

Anti-submarine warfare is a $1.370-billion item in the '61 budget—up $95 million over the current program. However, it is $220 million less than FY '59. Most of the shrinkage over the two years is in the procurement of major electronic hardware and in RDT&E.

Other current industry trends:

MICROMINIATURIZATION

Manufacturing techniques for the reduction of equipment size are being emitted at high frequency from every electronics conference. This is not just a fad—it's big business.

It went into high gear when the Army Signal Corps added a $5-million catalyst—the RCA contract to standardize microminiaturized components and assembly techniques. The missile industry needed this; so did the whole electronics industry.

Add to this the company-sponsored efforts in this field and the overall picture is one of nearly a billion-dollar technical revolution taking place over a three to four-year period.

More than 100 companies are working directly with RCA on its contract, and the rest of the industry is following the program with interest. All, however, are not convinced that this is indeed the correct approach—even though many of the techniques can be used on future systems whatever approach is used.

The current target is to achieve component densities of the order of 600,000 parts/cubic foot.

PHYSICAL ELECTRONICS

Those who feel the concept of microminiaturization is not the answer are attempting to make an evolutionary leap with physical electronics R&D.

Two major approaches have found vigorous sponsors in industry: molecular electronics and thin-film subsystems.

The Air Force came up with a $2-million development contract for Westinghouse after it had seen how much progress the company had made in its molecular-electronics effort. By using molecular-structure and atomic-field characteristics in various solid-state materials, complete subsystems had been created by Westinghouse researchers.

So far, over 20 of these functional subsystems have been made. According to the company, reproducibility is good, electrical efficiencies high (up to 70%), and unit reliabilities closely approach 100%. Essentially low-power devices, thermoelectrics used for power in the near future should increase reliability and vastly decrease overall size. Over 1000:1 size and weight reductions are believed practical, even over microminiaturized systems. The target now is development of a working system in from 3-5 years.

A major exponent of the thin-film approach is Motorola. Although not opposed to the molecular-electronics approach, it does believe it can do more, faster, with evaporative thin-film systems. Actually, the Semiconductor Div. in Phoenix also is starting a company-sponsored program to develop advanced functional subsystems.

Its program, called "microelectronics" will establish both physical and chemical techniques to form thin films of conductors, semiconductors, and insulators. By using "two dimensional" passive circuit elements and attaching unencapsulated active elements, it can realize component densities of 2 x 10^6 parts/cu. ft., Motorola says. It, too, will employ thermoelectrics for power.

The basic difference between this and the Westinghouse approach is that standard circuits will still be employed to obtain a desired function. Components will be distributed over the surface of a substrate and also will be stacked.

Only time will provide the answer as to which approach might be better. Probably the two will complement one another to provide the broadest possible range of future system configurations.

SEMICONDUCTORS

With new products coming off the manufacturing lines daily, plant expansions weekly, and new manufacturers springing up periodically, the semiconductor industry is certainly a prosperous one. Youthful, it is growing rapidly—in eight years its annual gross has climbed from five figures to a half-billion dollars. In another five years this figure will be doubled, according to industry estimates.

Three almost completely different product lines have evolved—for the military, industrial or commercial, and entertainment markets. Reliability requirements and a willingness to pay for high performance have produced a very high-quality military line. Low-quality producers either fall by the wayside or serve only the entertainment field. Competition for all of these markets is vigorous, which tends to assure good buyer prices in each market.

To compete, manufacturers first invested heavily to make better and different products. Now they are trying to automate to make them faster and cheaper. At the same time, most of the large manufacturers are involved in highly advanced research in "physical electronics," either solid-state functional systems or more nearly "conventional" thin-film subsystems.

Who are the leaders of this industry? There is a lot of money to be made, so—as might be expected—they are the giants in the electronics field: GE, Hoffman Elec., Hughes, Motorola, Philco, RCA, Raytheon, Sylvania, Texas Instruments, Westinghouse. Other companies, specializing in lower-quality products, may have lines just as diversified and may even sell almost as many units. But the giants have the quality markets.

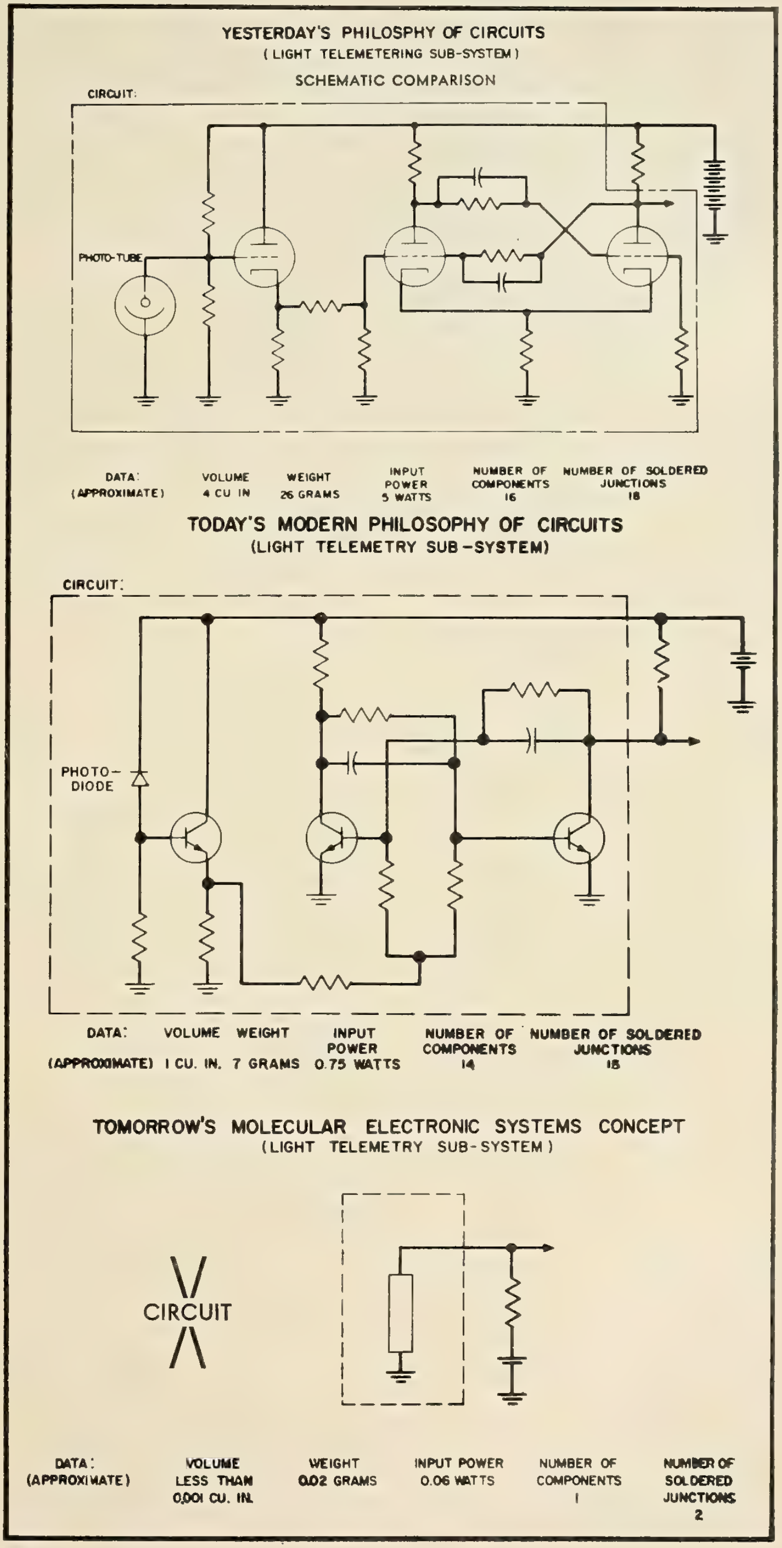
INFRARED

A fast-growing industry, infrared research and hardware market will have a total market approaching $400 million during FY 1960. Of this, nearly $125 million is for defense.

Significantly, a very large part of the IR defense dollar is for research. This is one field that has been only partly tapped. Given a few important breakthroughs, this industry could easily treble in size within a few short years.

Look at the range of applications: arming and fuzing missiles; missile homing; horizon and disc scanners (for use with vertical gyros and satellite attitude control systems); star-tracking

Changing Requirements in Circuitry



BLOCK DIAGRAM prepared by Westinghouse for M/R.

navigational systems; target detection, acquisition, and tracking; mapping; communications; vertical-over-height computers. These are just a few military applications; the commercial and scientific applications are twice as numerous.

One area receiving more attention now is IR communications. There are relatively few types of active infrared systems in use today, but for communications several advantages are readily apparent: narrow bandwidths and nonexistence of sidelobes and scatter (atmospheric) effects offer high communications security; non-interference, inherent with this mode of transmission, will guarantee spectrum availability; low cost and equipment simplicity will provide up to a 10-mile communication range (in fair weather). Frequencies used lie in the near-infrared region of from 86 to 375 megamegacycles/sec.

There are some limitations in the state of the art of IR communications, primarily the effect of rain or fog on system degradation. Former limitations such as poor detector sensitivity, high noise level, poor optical transmission materials, etc., are rapidly being minimized or eliminated through materials, research and new design techniques.

A comparison of radar versus infrared detection, considering only today's state of the art, indicates that each has certain desirable characteristics, but only within certain parameters.

Infrared has superior angular resolution compared with that of radar. Radar has a limited maximum unobstructed range but its range measurement capability is good. IR is just the opposite: unlimited range with poor measurement capability.

IR does have two limitations that probably will prevent it from ever supplanting radar. It cannot operate against the sun, and it is subject to more degradation in inclement weather. Performance is very poor in fog, impossible in dense clouds.

However, maximum radar range is a function of target reflectivity, beacon power and detector sensitivity. Nothing can be done about the former and no appreciable improvements have been made in the latter for some time. Power can be increased, but this is costly and relatively unrewarding.

Infrared detection—already good—has been improving steadily and rapidly. Detector sensitivities are being increased.

Also, the speeds and sizes of missiles and aircraft are increasing rapidly. As they do, IR detectivity improves significantly.

A great deal of time and money is being applied to problems of infrared cell cooling. Five major areas are targets of this effort: reliability, weight and volume, gas contamination, power requirements, and hardware costs. Included in these investigations will be an attempt to reduce cooling time and to solve the accessibility problems with missiles.

Liquid nitrogen systems currently are most utilized in this field, but Peltier-thermoelectric cooling seems to offer the greatest opportunity for real gains in making reliable, small-sized, low-power systems.

Electronics in ASW

(NOA, in millions)

Navy Appropriation	Fiscal Year 1959	Fiscal Year 1960	Fiscal Year 1961
RDT&E	[1]$ 202.7	[2]$ 225.3	$ 180.5
Shipbuilding & conversion	1,012.6	485.7	762.3
Aircraft & related procurement	266.3	476.8	345.2
Procurement of ordnance & ammunition	54.1	50.2	55.2
Major electronics procurement	60.1	37.9	27.6
Total, all appropriations	**1,595.8**	**1,275.9**	**1,370.8**

[1]Includes $20,500,000 DOD emergency funds.

[2]Includes $45,000,000 Congress add-on.

DATA RECORDING

Expecting to do over $200 million in equipment sales alone during FY 1960, the 13-year-old magnetic tape recording industry has matured rapidly. Extremely versatile, it has found application in data processing systems, industrial machine control, telemetry, automatic checkout, video, training, entertainment, and a host of other areas.

Just a few years ago, magnetic tape was used to record frequencies up to several thousand cps. Although tape limits had not been reached, equipment limitations were the problem. Today, frequencies above 500 kc are becoming more common; video recording exceeds 6 mc and may soon accommodate 12 mc. Theoretically, some researchers believe it may be possible to reach a limit of 100 mc; but more must be known about magnetic materials before this can be proved.

Development in missile-borne systems has been toward compact miniaturized units, designed for specific applications. The knowledge gained, however, is being reflected in smaller systems for all applications. Lockheed Electronics and Avionics, Ampex, Datalab, Leach Corp., and others have produced extremely successful units, some weighing well below 20 pounds total (excluding power supply only). All of these systems are rugged and reliable with fairly high information capacity.

THERMOPLASTICS

An eventual threat to the magnetic tape industry is General Electrics' new thermoplastic recording (TPR) process. True, it may complement the now-standard and versatile magnetic tape, but it surely will make heavy inroads on the market.

Its application will be both military and commercial. Even in its developmental form, it can concentrate in a given space 100 times as much information as magnetic tape. Its output can be digital or it can produce color or black and white pictures.

PHOTOSCAN

Another new competitor, somewhat more limited in scope, is CBS Laboratories' Photoscan system, using highly advanced scanning and radio-photographic techniques. Directly applicable for missile and aircraft surveillance missions, it provides a means for almost instantaneous pictorial data acquisition and storage.

It can be used with various types of sensors, and it provides very high vertical and horizontal resolution. According to CBS, no loss is incurred in data transmission and the ground station equipment employs image-enhancement techniques to provide an even better photographic image.

GRAPHIC RECORDERS

Many types of graphic charts have been used in recording data for missile system checkout and telemetry. Early oscillographs and pen recorders were slow in response and subject to inertia errors. Photo-recording graphs had to be chemically developed in a longtime process that provided data only after considerable delay. Laborious and inaccurate manual reduction further complicated the process.

As new recording techniques gained in popularity, the older methods have had to be improved steadily. These improvements have come, and many of the older types have held their own very well.

Heat-sensitive recording papers and instantaneously developed photographic oscillograph charts have brought significant progress in galvanometer techniques. In addition, response and speed of these systems also have been improved to the point where they are sufficient for almost any application. Some models offer combinations of different methods in one machine—heat, electric, ink, curvilinear and rectilinear recording.

Other features aimed at providing better, faster and more convenient recording include record numbering, electronic flash timing, variable speeds, plug-in modules, and instantaneous readout. Present trends indicate emphasis on transistorization and higher-frequency response.

Probably the most advanced step made in graphic recording is the multi-stylus technique—using electrosensitive chart and electronically fired multiple fixed styli. Such systems, capable of plotting millions of data points each second, can provide both discrete-level analog plots and alpha-numeric annotation. They are particularly useful in recording sequential on-off data. The growing popularity of this technique is attested to by the increasing number of different models becoming available. At present, however, costs are high and systems complex, making them useful only in certain advanced applications.

ENERGY CONVERSION

The field of energy conversion for producing electric power is still confusing—both as to the amount of money it represents in continuous military and industrial investment and regarding the number of companies involved in serious research, development and production.

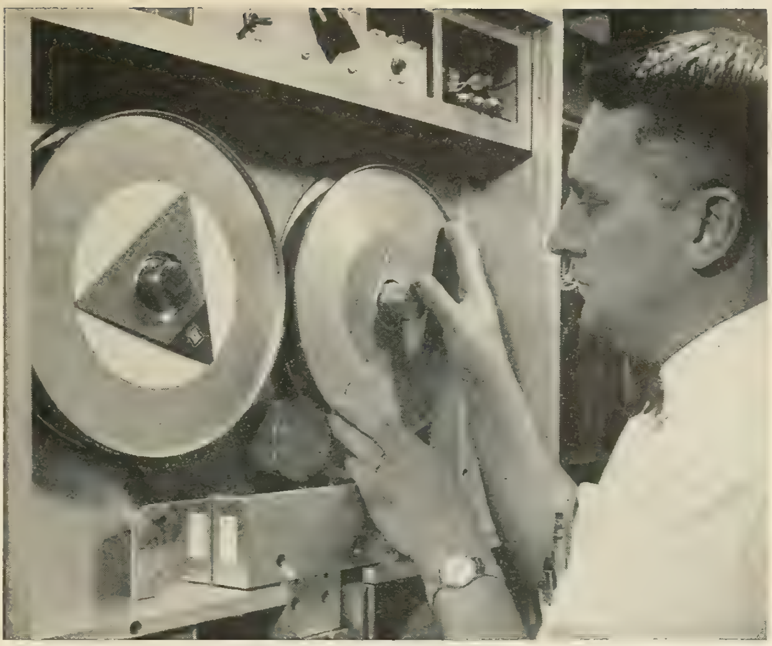
Total DOD funding is nearly $50 million a year. But how much industry is plowing into this potentially lucrative field is an unknown—except that it is a very sizeable sum.

The missile/space age has provided the necessary impetus because of the unusual auxiliary power requirements of its vehicles. And the commercial applications of advances in the field generally create more profits than do military or scientific use. The push is aimed at direct energy conversion.

Most recent estimates indicate that more than over 1000 companies contribute either directly or partially to energy conversion advancements. Areas of greatest interest today appear to be photoelectric and photochemical (both solar-type systems), thermoelectric, electrochemical, and thermionic emission.

NASA's money is going into solar-cell and regenerative fuel-cell development. The Air Force has spread its money over a broad area: solar cells, nuclear and nucleonics, fuel cells, fluids research. The Navy has been concentrating on fuel cells and thermolectricity. Army is aiming its dollars at fuel cells and solar cells. The AEC has worked almost solely with its SNAP development program. These use nuclear energy for indirect power conversion.

Fuel cells are enjoying by far the most widespread interest. Needless to say, battery manufacturers are using a great deal of their own money to stay in the field. Today they are doing well; how long they retain a large piece of the pie certainly depends on advances in these other areas, but so far battery makers have shown a lot of staying power.



HIGH-SPEED magnetic tape drive newly developed by Datamatic Division of Minneapolis-Honeywell can read or record 96,000 decimal digits per second. It is reported to be the most efficient tape handling system yet devised. Use of an all-vacuum rather than a mechanical drive is expected to virtually eliminate damage to magnetic tapes.

FUZING & ARMING

Shrouded by necessary but often inconvenient secrecy is the field of fuzing and arming, both for conventional and nuclear warheads.

The work is highly advanced technologically, but many observers feel that continued state-of-the-art advancements are being cramped by the security veil and lack of a centralized information "clearing house."

It's a one-customer market, and there are only five companies having a major interest: GE, Bulova, Minneapolis-Honeywell, Maxson, and Avco-Crosley. About 10 others are important but limited suppliers, and fewer than 40 major component suppliers complement the industry.

This also is one field in which the government has no shortage of experts. Its agencies all have very complete R&D in-house capabilities—not only in fuzing and arming per se, but in associated electronics and accessories.

Principal government agencies are the Army's Diamond Ordnance Fuze Lab and Picatinny Arsenal; the Navy's Ordnance Labs at Corona, Calif., and White Oak, Md., and the Ordnance Test Station, Inyokern, Calif.; the Air Force's Air Research and Development Command and Special Weapons Command; and the Atomic Energy Commission.

Ten-Fold Increase in Facilities Forecast

Military demands expected to parallel commercial requirements. More roles for satellites seen

by Theodore J. Meek*

Although today's long-distance communications facilities are highly congested, a ten-fold increase is forecast in the next ten years. While the increasing use of transoceanic cable offers needed temporary relief, it is to the use of satellite systems that we now must look for a potentially more permanent solution.

Not only is the need for commercial facilities mounting rapidly, but military demands are expected to parallel this growth with even greater emphasis on reliability and mobility. Satellite systems appear to be ideal.

These demands are based on presently known requirements. However, if there are additional requirements for global real-time television transmission, world-wide control and programming of aircraft, and vast data handling systems for global surveillance systems, missile test ranges and tracking stations, then the urgency is more imperative to develop and use satellite systems.

The rapid growth of the world's population and its expanding area of interest make it mandatory that all means of communication be exploited.

In the Congressional presentation of the 1960 NASA budget, Dr. T. Keith Glennan outlined U.S. objectives in the exploration of outer space and the benefits in the economic realm that could accrue from such exploration. Communication satellites were particularly emphasized in making possible transocean and intercontinental video and telecommunication services.

Satellites for communications purposes may serve simply as passive reflectors of electromagnetic waves or, with appropriate instrumentation, they may be active repeaters. In the active case a transmitted signal is received from the ground, amplified, and retransmitted at a different frequency. While each method has its own advantages and disadvantages, there are a number of problems that affect each method to a greater or lesser extent.

Major problems such as frequency considerations, effects of environment, and certain electrical phenomenon will be discussed later. But first, let's review some of the near-future satellite projects.

• **Project** *Echo*—The National Aeronautics and Space Administration will provide the first opportunity for investigating the application of passive satellite relays to global communications.

In the spring of this year, it plans to launch a 100-foot diameter inflatable reflecting sphere into orbit and to establish communication circuits using it as a passive repeater. This will be the first of three intended launchings, although NASA does not have scheduled plans at this time for the other two satellites.

The communication circuits are to be a combined effort of NASA, Jet Propulsion Laboratory (JPL), Bell Telephone Laboratories (BTL), and the Naval Research Laboratory (NRL). The JPL site at Goldstone, Calif., will transmit via the satellite on 2390 mc and receive on 960 mc. The BTL site at Holmdel, N.J., will transmit on 960 mc and receive on 2390 mc. The NRL site at Stump Neck, Md., will receive only 26 2390 mc.

The first sphere will be launched by a Delta rocket from Cape Canaveral into an orbit inclined at 50° to the equator. To aid in tracking the satellite, a beacon transmitting on 108.00 mc will be carried by the third stage rocket, which should trail closely behind the payload for the first two or three passes around the earth.

The NASA Minitrack network will establish a preliminary ephemeris. If visibility permits this will be augmented by the Smithsonian Astrophysical Observatory Optical Tracking Network.

The NASA Goddard Space Flight Computing Center in Washington, D.C., will compute the satellite ephemeris for the third pass and transmit the data in digital form to the Goldstone site. This information will control the direction of the receiving antenna, and the transmitting antenna will be slaved to the receiving antenna. The receiving system at Goldstone, being designed to receive both frequencies simultaneously, will use the 2390-mc signal to make a self-tracking system of the Goldstone transmitter and receiver.

Tracking information also will be supplied to the Holmdel antennas in digital form from the Computing Center, or, if visibility permits, by an M-33 optical tracker. The NRL receiving antenna will be positioned by the same digital data.

While it is not known what tests NASA and BTL plan to conduct once the communication circuits have been established, it would be possible for them to investigate the effects of Faraday rotation of polarization caused by the magneto-ionic properties of the ionosphere, fading caused by scintillations in the reflection from the satellite, and the effects of different polarizations.

• **Military projects**—U.S. Military plans for communications relaying earth satellites are far more advanced and sophisticated than Project *Echo*. Brought together under a single development project called *Notus* are plans to launch several delayed-time repeater satellites in low-altitude orbits, two real-time repeater satellites in po-

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lar orbits, and several real-time repeater satellites in "stationary" orbits.

The various launchings are to be accomplished under discrete tasks. Task *Courier*, which is actually a continuation of Project Score (the Christmas-1958 satellite), will launch several satellites into circular orbits at relatively low altitudes of about 650 miles. This is expected to take place over a three-year development period beginning in mid-1960.

Each of the satellites will contain a receiver, transmitter, magnetic tape recorder and playback unit, and a triggering device. As the satellite passes over a transmitting ground station, it will receive the transmission and record it. Then, as it passes over other ground stations, those wishing to receive will trigger the repeater with a coded command signal causing it to transmit the stored information.

The real-time, or instantaneous, repeater satellite will be launched into orbit under Task *Steer*. Its purpose is to provide two-way communications in the polar regions.

Task *Tackle* will follow *Steer* with a more advanced type of communications repeater. This satellite is to be launched into a 6-hour polar orbit by a modified *Atlas*, and is intended to provide two-way ground-to-air and ship-to-shore communications.

Task *Decree* is the code name for the real-time repeater to be placed in a 24-hour equatorial orbit, also by a modified *Atlas*. This orbit, at an altitude of 23,300 miles, will result in the satellite remaining fixed in relation to a point on the surface of the earth; its angular velocity will be of the same direction and magnitude as that of the point on earth.

The first repeater to be sent up is intended to relay a large number of voice channels. A subsequent, larger *Decree* satellite, to be boosted into position by a *Saturn* clustered rocket, is expected to provide even greater traffic-handling capacity. A development period of from five to 10 years has been estimated for this task.

• System impact—With the approach of the era of space satellites a whole new series of problems will come into existence. Probably, some as yet cannot be foreseen; others having to do with economic, sociological, and international aspects may be expected to have a vast impact on our way of life.

From the point of view of economics, it is necessary to consider the costs involved. Funds totaling $230 million have been made available to the rocket-booster program. The major part is expected to be spent on the *Saturn* booster and its most important payload may be the 24-hour communication satellite.

Development Programs for Communication Satellites

	PROJECT		ORBIT	AGENCY
Passive	ECHO		1000-MILE INCLINED	NASA
Active	NOTUS:	COURIER	500-MILE INCLINED	ARMY
		STEER	6-HR POLAR	AIR FORCE
		TACKLE	6-HR POLAR	ARMY
		DECREE	24-HR "STATIONARY"	ARMY

Until a working system is established, accuracy of cost estimates is subject to a wide margin of error. If costs for developing the means of placing the satellite in orbit are neglected, very rough figures can be estimated. For example, three equally spaced active satellites in a 24-hour orbit, arranged to provide video bandwidths for near-global coverage, might cost $100-300 million.

The sums contemplated here are not the whole picture. Ground switching equipment of a complexity and scale hitherto not contemplated will be necessary. Computers will be needed for the effective utilization of the many channels and information thereon can be expected to show how the channels can be used most efficiently.

International agreement will be necessary as far as frequency allocation is concerned. However, the possibility of international cooperation should not be overlooked in the economic realm. Since satellite communication is by its very nature international and tremendously costly on an overall basis if not on a per channel basis, there exists the possibility of international funding.

The sociological impact of the establishment of a global communication system can have far reaching effect. The increased world-wide communications may provide a lessening of world tensions. Television coverage will have a profound influence on the peoples of different nations. With intelligent use, the interchange of social customs could result in far better understanding between nations.

• Active repeater satellite—If a satellite is placed in an equatorial orbit at about 22,300 miles above the earth, it will rotate about the earth at the same angular velocity as the earth rotates on its axis. It then appears stationary with respect to a point on the earth's surface.

Such a satellite suffers from high-path-loss of the order of 400 db, depending on antenna considerations and frequency. However, if an active repeater is placed in the vehicle, the burden on ground equipment is greatly reduced and brings it within present-day capabilities.

Among the problems to be solved before an active satellite can be placed in a stationary orbit are methods of establishing and maintaining it in orbit, electronic and mechanical design of the payload, power supply, and methods of ensuring reliability.

Large boosters such as *Saturn* will be required to place the satellite in orbit.

Some authorities have suggested a minimum life span of the satellite in orbit as two years. As more sophisticated controls become available, it would seem reasonable to expect a longer life.

Electronic hardware must be developed specifically for this application. In spite of the fact that no extraordinary powers are contemplated, a 10-watt transmitter in the vehicle should be able to provide television channel bandwidth.

One of the main problems of an active satellite will be the provision of a power supply for the RF repeater. Both power sources and energy sources have been suggested. The power sources that convert sunlight by solar batteries into watts have a fairly low efficiency. A more radical technique using a strontium brick in a heat engine shows promise of yielding far higher efficiencies, although a considerable shielding problem would exist.

Energy sources are represented at present by high-performance batteries, but fuel cells show promise of high efficiency if the weight-size problems can be solved.

Many subsidiary problems will arise and their solution can be looked for in future development. Thus, a satellite at an altitude of 22,300 miles will have a group delay of about 250 milliseconds. Means to minimize problems associated with this condition must be looked for. Optimum methods of modulation and detection will have to be examined with particular attention to low-noise wide-band techniques for uses which will be dictated by the severe requirements of spatial communications. Deleterious effects due to Doppler shift may be expected to be a function of the particular modulation method used.

• Passive repeater satellite—In the passive case, very high-power transmitters and low-noise receivers are necessary. At present it appears that low

altitude orbits are most attractive because of noise considerations and suggestions have been made for the establishment of a multiplicity of satellites to provide world-wide coverage.

In an operating system, communications via satellites may not be practical for elevation angles down to zero relative to the horizon, because of the effects of the atmosphere on radio-wave transmission. Atmospheric scintillations may make accurate tracking of the signals difficult at low angles.

In addition, the temperature seen by the antenna rises sharply due to increased oxygen and water vapor absorption, and ground losses, when small elevation angles are approached. This factor is significant when exceptionally low-noise receivers are contemplated for the system. An angle of 7.25° has been suggested as the minimum elevation angle.

Some investigators have suggested that about 80 satellites would be required in an equatorial orbit at a height of 2500 miles for a reliability of visibility of 99.9% over a trans-Pacific path. This was under the assumption that the satellites would be randomly spaced.

Random spacing alone poses a problem and means of placing them in orbit to avoid excessive "bunching" needs investigation. With a guidance device, more desirable spacing could be programed requiring many fewer satellites.

In considering antennas for use in passive satellite communications, antenna beamwidth must be greater than probable satellite tracking error. Also, it must be wide enough that signals will not be greatly affected by refraction in the troposphere and ionosphere resulting in refractive scintillations and causing severe fading of the signal. The antenna mount must be able to move the antenna at the angular velocities and accelerations necessary to track the satellite.

Present techniques used in locating satellites and predicting their future position are refined to the point where azimuth and elevation angle can probably be predicted to ±0.1°, 24 hours in advance.

An examination of path loss indicates that very large antennas or improved receivers are necessary if transmitter power is to be held to a reasonable amount. Although antennas up to 600 feet appear feasible, it would seem unreasonable to use them for ground communications via earth satellites, rather than reserve them for communications.

The development of new low-noise receiver techniques in the uhf region has improved receiver noise levels to the point where noise from external sources must be considered. Receiver noise figures of 1 db are now possible at 4000 mc by using masers.

The near future certainly will see the development of parametric amplifiers to give similar noise figures in this frequency range. This corresponds to a receiver noise temperature of 76°K, which is well below the noise temperature of the ground and some extra-terrestrial sources at 4000 mc.

Receiving system losses must be minimized and the deleterious effects of antenna side lobes illuminating the ground or other nearby objects must also be recognized.

Further consideration must be given not only to man-made noise but to noise from extraterrestrial sources.

• **Frequency considerations**—Frequencies most suitable for space communications appear to be from about 100 to 10,000 mc, the lower limit being determined by galactic noise and ionospheric reflection and the upper limit by absorption due to water vapors. There appears to be a definite RF window from about 30 to 50 kmc, and above 60 kmc.

The oxygen-molecule absorption band appears to rule out transmission in the region between 50 and 60 kmc.

An extensive development effort will be required before effective use can be made of twice higher frequencies and in the meantime it will be necessary to make use of the lower band. While this is an attractive spectrum, it is being used currently by terrestrial services.

The problem of frequency interference arises even before space systems are in general use. Space communications, however, almost always involve line-of-sight transmission, and antenna directivity is one method of interference control.

The jurisdictional problem seems most difficult of solution. It will be necessary for all nations to agree on frequency assignments and on the manner in which the satellites will be used.

Finally, there are a number of important physical effects that must be explored. One of these is the effect of Faraday rotation of the polarization of the propagating wave as it travels through the atmosphere. The resulting decoupling loss at the lower frequencies will be serious. The frequency dependence of this effect should be explored carefully.

The use of circular polarization appears to be the best choice for passive satellite communications due to the effects of Faraday rotation. Among other problems, if linear polarization were used, the fading experienced at the receiver due to this effect would be severe and would require excessive margins of transmitter power.

• **Environmental effects**—A fundamental requirement of the satellite system is that it operate unattended with a very high degree of reliability. Possible sources of damage are bombardment by meteorites and high-energy particles, deleterious effects of residual atmosphere, and temperature.

No conclusive information is available on meteorite density and data on particle magnitude is conflicting. Studies have indicated that the possibility of skin puncture is very much greater than the probability of damage to components inside the vehicle.

In the case of the active satellite it has been suggested that a relatively lightweight shielding might give protection to critical elements and that the antenna might be protected with a dielectric sheet.

Besides meteorites, satellites will be subject to constant bombardment by high-energy particles from various sources such as cosmic and ultraviolet radiation, nuclear power supplies, and the Van Allen belts.

It has been postulated that damage due to primary cosmic radiation will be negligible but that secondary effects may produce damage after collision of primary high-energy particles with nuclei in the satellites' skin.

While the Van Allen belt of charged particles may not damage components, noise may be increased and the entire effect, particularly at the higher altitudes, is still unknown.

The effect of any residual gas molecules striking the surface of the satellite might be to cause sputtering by the removal of atoms from the metal surface. The normal oxide film will inhibit such effects, which are not expected to be a problem at altitudes above one hundred miles.

At stable orbit altitudes the major influences controlling temperature are the characteristics of the outer surface of the satellite, placement of heat-generating components, altitude and orbit. It is expected that temperature inside a satellite can be controlled within 40°C.

In the ionosphere it has been observed with ballistic missiles that power in excess of 3 watts to the antenna will cause ionization arc-over across the "leaky waveguide" opening used. While not strictly an environmental effect this phenomena may require delayed operation of high-powered transmitters while passing through the ionization region before a stable orbit is established.

Automatic Test Equipment Burgeons

Sophistication and poor relation of checkout with weapon are major problems hiking costs

by Charles D. LaFond

A hard look at today's automatic test equipment reveals an endless variety of systems. The field becomes kaleidoscopic as the view is narrowed —there is agreement on overall summetry, but the system appoaches are different. The field is still so new that none of the users are convinced yet as to which approach is really best.

Five years ago, a few farsighted manufacturers faced up to an inevitable problem in logistics. They determined that with the ever-increasing complexity in all types of electronic and weapon systems, the need for specialized test equipment would overprice already costly sophisticated systems. Testing time, manpower, and reliability requirements demanded a more practical approach to factory and field checkout procedures.

Their concept—a universal automatic test system—was not new; only the incentive of a potentially broad market was required to advance it from dream to reality. Progress since has been rapid.

• **Today's market**—Consider only the missile/space market and you find a highly lucrative sales area. Total FY 1960 expenditure approaches $7 billion. Missile support equipment will require roughly $3 billion—and half of this is for electronics systems. Depending on how you define it, automatic test equipment expenditures should reach nearly $450 million, or 30%, during FY 1960. And this is only a beginning.

True, more selectivity in missiles may be the policy as time goes on; but, while there will be fewer missile types, more of each type will be produced as it achieves operational status. With greater dispersion of the missile arsenal, more checkout units will be needed in the field to assure readiness.

By-products of those proven military devices will surely appear throughout many other industries. The potential there may be tremendous, but a "guesstimate" is hardly worthwhile until more is known about today's equipment applications and limitations.

• **Costs**—A survey performed by The Rand Corporation showed that the five-year maintenance cost for one weapon system was more than 10 times original system cost. The total included costs of support equipment, technician training, and spare parts provisioning.

The Rand study also indicated that lower downtime for complex systems adds excessively to overall costs because of the spare systems needed to assure constant combat readiness.

The use of automatic checkout equipment may solve many of these problems. Stromberg-Carlson recently stated that application of its SCATE in testing one complex system reduced a 12-hour manual test program to five minutes. Similarly, Convair-Pomona found that the use of its BOFTE system for *Terrier* checkout reduced total time by 75%. Cost per test dropped 97.5%. Costs of the automatic system approximated total cost of all individual, special, test units previously used.

• **Characteristics similar**—Successful checkout equipments in use today have many attributes in common. They reflect the practical advantages of automation and current fabrication techniques:

1) Initial self-checking, continuous self-verification, and fail-safe features assure high reliability and confidence.

2) Employment of stimulus-response patterns for testing provides consistant and complete performance of test sequences for fault location from subsystem to part.

3) Standardized test procedures and permanent output record provide coherent history for subsequent analysis and evaluation.

4) High-speed testing permits precise dynamic performance measurements where it previously could not be evaluated adequately (servo systems).

5) High-speed testing saves useful operational life of systems under test by reducing test time.

6) Standardized modular construction assures ease of modification or system expansion.

7) Automatic checkout cuts total manpower requirements, reduces required skill levels of operating personnel, and minimizes human error.

• **Problems**—Many observers feel that developments may have exceeded today's requirements. Increased sophistication in checkout systems has brought an even greater cost increase.

With the exception of Lockheed's ACRE (for *Polaris* checkout, surveillance, and countdown)—which is probably tops in current sophistication and cost, the automatic checkout systems finding broadest use are those employing proven parts and circuits, resulting in low development costs.

Yet the Air Force reportedly has written its automatic checkout equipment specification, MIL-T-26664, around North American's GS-1A system. This is a fully transistorized, complex system capable of testing a vast number of functional systems at high speed. It is an evolutionary basic system resulting from development and use of two earlier systems dating back to 1955.

Still high on the list of problems is the urgent need for early marriage of checkout system with weapon system. Without this, costs are unnecessarily raised and test efficiency is lowered. An awareness of the problem, at least, exists now; the new generation weapon systems will reflect this philosophy in their initial design. The situation can be corrected only in part with new members of old missile families.

Other developments needed to solve existing problems are:

• Cheaper and more adaptable test units.

• Better but not necessarily more complex fault-isolation techniques.

• Programable stimulus generators flexible enough for broad application—preferably a "family" of standardized adapter modules.

• **Human engineering**—One area in automatic test equipment development receiving increased emphasis is "human engineering." This may merely reflect a general trend in industry to place more weight on this aspect of design.

Chief purpose, of course, is to insure final designs offering the equipment configuration most efficient for both operation and maintenance.

A major proponent of this approach has been Stromberg-Carlson, particularly in its development of the SCATE system. The company also en-

listed the aid of consultants from Dunlap & Associates and Courtney & Company, specialists in human engineering.

Engineering-psychological parameters considered were such design factors as character legibility, brightness, position determination, accessibility, and operator comfort. Indicator knob and button characteristics were determined by a combination of factors: use frequency and sequence, visual intensity of light sources, and all necessary anthropometric, motor, and visual data. The final effort was to develop the most efficient operating and maintenance procedures for the man-machine system.

• **System descriptions**—With the many systems currently in use, there are naturally many differences—some unique. The accompanying chart is a breakdown of the manufacturers of major checkout equipments and the missiles with which their systems have been or will be associated.

Some of the individual characteristics of many of these systems are described briefly below (the "standard" characteristics listed above apply to each unless otherwise noted):

• ACRE, Automatic Checkout and Readiness Equipment, is a joint Lockheed, Packard-Bell effort. As indicated earlier, this is a most ambitious development—highly sophisticated and functionally ambidextrous.

Actually, there are two systems: ACRE-SSBN, for tactical use aboard *Polaris*-armed submarines; and ACRE-Octopus, for factory and depot use.

Initial programing is with magnetic or perforated tape input to a magnetic-drum memory. A magnetic-core buffer permits temporary storage of test data.

The system will not only perform the more "conventional" missile tests; it performs continuous readiness checks and final countdowns.

For maximum reliability, dual redundancy is incorporated in the system design.

• In reviewing Radio Corp. of America's checkout developments, a swarm of acronyms soon results. Nevertheless, here is a rapid summary:

Out of a 1955 Army Ordnance contract to RCA for a comprehensive R&D program to standardize guided missile test equipments came certain design criteria. From these, RCA developed DEE, Digital Evaluation Equipment. Together with MEE, Mechanical Evaluation Equipment, the program evolved into MPTE, Multi-Purpose Test Equipment. The program now is called GEE, for General Evaluation Equipment.

DEE is a basic electronic checkout system for third and fourth echelon maintenance. It is transistorized and has a high density magnetic tape storage input.

A unique feature is a provision for waveform analysis: pulse widths 0.2 to 10 μsec. $\pm 10\%$; pulse amplitude 0.5 to 200 volts $\pm 10\%$ (slope and tilt linearity accuracy of $\pm 2.5\%$); rise time 4 μsec to 0.2μsec. $\pm 5\%$.

• SCATE, Stromberg Carlson Automatic Test Equipment, has enjoyed broad usage. Transistorized, it uses perforated-tape programing.

The system is largely self-adjusting and self-calibrating. It features simple and relatively low-speed operation with high measurement accuracy: dc voltage to 0.01%, frequencies to one part in 10^5 or better.

• DATICO, Digital Automatic Tape Intelligence Checkout, was conceived by Nortronics Div. of Northrop Corp., in 1956, born in 1958. Since that time it has had broad usage.

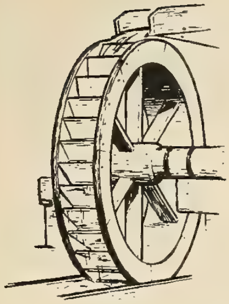
Generally unsophisticated, it is a low-speed system, simple and reliable. Programing and control are by perforated tape and patchboard.

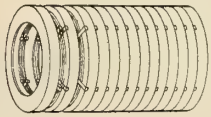
NORSCAN, Nortronics System Computing Analyzer, skips several evolutionary steps in comparison with DATICO. This is an all-transistorized prototype employing solid-state switching. Very high-speed, it features perforated tape initial programing, magnetic drum storage, and a core buffer.

A stored "confidence index" will provide a scale against which readings

Missile Systems and Test Equipment

	ATLAS	BOMARC	CORPORAL	CORVUS	FALCON (Series)	HAWK	HOUND DOG	JUPITER	LACROSSE	MACE	MATADOR	MINUTEMAN	NIKE AJAX	NIKE HERCULES	NIKE ZEUS	POLARIS	QUAIL	REDSTONE	SERGEANT	SIDEWINDER	SNARK	SPARROW III	TALOS	TARTAR	TERRIER	THOR	TITAN
AUTONETICS, N.A.A.							■					■															
BENDIX RADIO DIV.										■																	
BENDIX-YORK DIV.																							■				
CHRYSLER CORP.								■										■									
CONSOLIDATED SYSTEMS CORP. – C.E.C.	■																										
CONVAIR POMONA																				■				■	■		
DuMONT								■														■					
EPSCO	■														■										■	■	
GOODYEAR										■																	
HUGHES AIRCRAFT CO.					■																						
HYCON																								■	■		
ITT – FED. DIV.		■																									
LOCKHEED & PACKARD BELL																■											
MARTIN – BALTIMORE										■	■																■
McDONNELL																	■										
MINN.-HONEYWELL	■																										
MOTOROLA		■																									
NORTRONICS			■			■			■				■	■		■			■		■						
PHILCO CORP.																				■							
RCA	■																										
RADIATION, INC.	■	■																									
SPERRY RAND																			■								
STROMBERG CARLSON	■	■													■												
TEMPCO				■																							





Solar energy conversion: Through recent advances in materials and electronics, we are on the threshold of a new era of energy utilization. By concentrating solar radiation into the cavity of a thermionic converter, electrical power is generated directly from sunlight without moving parts or circulating fluids. This freedom from earthbound energy sources promises far-reaching applications in space exploration. Artist's concept shows the unfolding of a solar collector mirror with its central power package which would be attached to various types of space vehicles. Lockheed design of thermionic converter operating model is shown at left. The water wheel depicts one of man's earliest known forms of energy conversion.

THERMIONICS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

The development of new techniques in energy conversion is typical of the broad diversification of work at Lockheed Missiles and Space Division. The Division possesses complete capability in more than 40 areas of science and technology – from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space communications; space medicine; space navigation; and space physics.

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Lockheed /

MISSILES AND SPACE DIVISION

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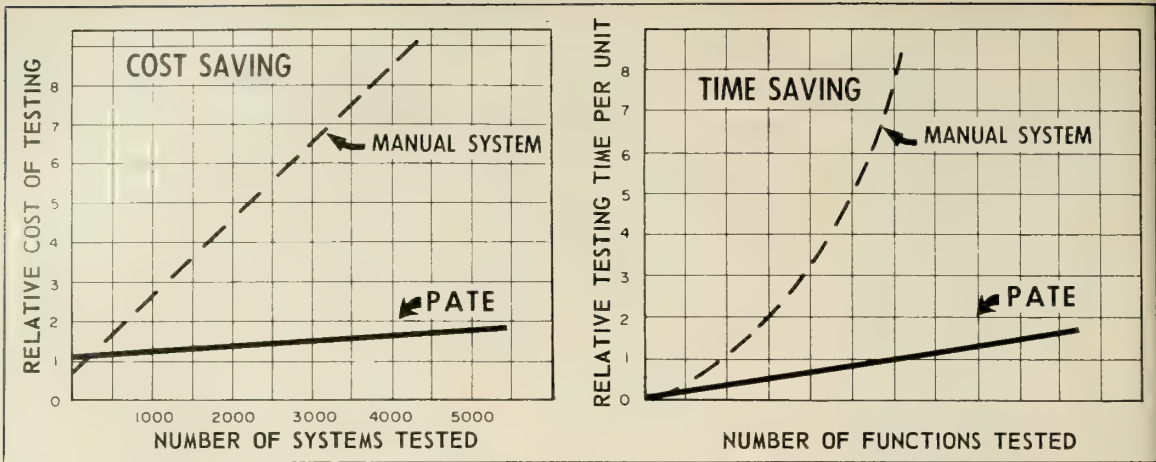


COMPARISON OF COST and time savings of Motorola's PATE to a missile system. Motorola developed an earlier checkout system for the Navy's *Terrier* antiaircraft missile.

may be compared to provide an indication of how good a "GO" readout really is.

• The Curtiss-Wright DEMON, like NORSCAN, is a highly advanced solid-state system. Programing is similar, with magnetic tape used for storage. A buffer memory provides time-scale changing from the 12,500-character/sec main storage rate to a random rate.

• PATE, Programed Automatic Test Equipment, developed by the Military Electronics Div. of Motorola, Inc., Phoenix, is the result of a program dating back to 1955. An early checkout system was developed for Convair's *Terrier* missile. More advances came with development of TGSE system for the B-58 Hustler IFF packages. This was tape controlled with sophisticated pulse-tape measurement units.

Finally, the more flexible PATE evolved for use with the *Bomarc* data link. Primarily solid-state, it has minimal switching characteristics and uses a mechanical tape reader, but can be provided with an optical reader for increased speed. Programing is digital with perforated tape. No storage unit is provided.

A particular feature of the system, according to Motorola, is that it can measure, in terms of synchro voltage, instantaneous shaft position and instantaneous angular velocity to an accuracy of ±0.05°. System measurements are accurate to 0.001% full scale.

• The GS-1A and the more complex C2-49A automatic checkout systems, developed by Autonetics Div. of North American Aviation, are fully transistorized.

Completely self-contained, these high-speed systems make use of a complete initial self-test routine and four separate self-verification checkout procedures during operation.

Both use digital techniques and perforated-tape programing. They have evolved out of an earlier GS-1 and the Mark II Automatic Tester, first developed for *Navaho* back in 1955.

• BOFTE, Bureau of Ordnance Fleet Test Equipment, developed by Convair-Pomona, is a relatively low-cost high-speed system. The Convair approach is somewhat different from most other checkout systems.

It employs Remington Rand punch-card programing. Missile systems under test are energized only during the performance of the tests. Output is stored in a magnetic-core memory unit. Readout and evaluation are performed after missile-systems shutdown.

• RACE, Rapid Automatic Checkout Equipment, was originally developed by Sperry Microwave Electronics Div.—Sperry Rand Corp. for the B-58 Hustler's bombing/navigational system. It can provide an analog voltage or digital output. A high-speed system, it is programed with perforated tape.

In use with the *Sergeant* surface-to-surface missile, a special time generator provides base and control for all timing operations. Time base is with a 1-kc transistorized oscillator, accurate to 0.001%. The generator itself is accurate to 1-msec. and has 5-msec. repeatability.

• TATTE, *Talos* Automatic Tactical Test Equipment, is a Bendix-York Div. system.

Using perforated-tape programing, it was designed for both depot and shipboard use. An initial self-check can be programed into the system, but thereafter verification is manually actuated at the operator's discretion.

A *Talos* simulator also has been developed by Bendix for use in checking out TATTE and for training purposes. It simulates several models of the *Talos* missile.

• The AN/DSM-32 is a low-cost system A. B. DuMont Laboratories, Inc., designed for guidance and distributor parts of *Jupiter* missile checkout.

To reduce circuit complexity and overall size, yet retain flexibility, DuMont used patchboard programing. Because it employs analog-computer patching techniques, total test functions are somewhat limited.

There are also some advantages. For example, the scanning sequence can be optimized without time-sequenced programing inputs since all plugboard contacts are available simultaneously. Stepping switches can therefore be used on a single-incremented basis —one step per test. Test sequence is fixed, and stepper hunting is eliminated.

• The AN/DSM-54 and -55 Missile Test Sets are two similar systems developed by Hycon Mfg. Co. for the Navy's *Terrier/Tartar* group. These too are lowcost equipments designed for broad flexibility and maximum use of Federal standard parts.

Programing is by perforated tape. It also uses replaceable overlays to modify panel nomenclature for different missiles or types of tests.

• Guardian, also transistorized, is a high-speed system using digital techniques. Developed by Monitor Systems, Inc., a subsidiary of Epsco, the system has one particularly unique characteristic. It employs an "urgency selector" which offers the operator two or more alternate test routines depending on the degree of urgency of the previous test result.

• The UG-897 Systems Analyzer was designed by Minneapolis-Honeywell for the McDonnell F-101B flight checkout. Relatively low-speed, its developers believe it offers unusually high reliability and simplicity.

Bright Future But New Demands

by Hal Gettings

The future of telemetering is very bright, according to the authors of the newest book on the subject.* They say that "as long as there are experiments conducted remotely, involving any form of measurement, telemetering will always be in demand. With the whole vast realm of space to be explored . . . there seems little chance that telemetering . . . will be adequate for very long at a time. The conditions and environments of the future telemetering's operations should . . . provide challenging problems for many new generations of telemetering engineers."

In spite of the rosy picture painted, there is doubt in some quarters that telemetry is progressing at the rate necessary to keep up with its vital function. As pointed out in a previous article, (M/R, Oct. 5, 1959), lack of unity and coordination among those concerned with the field has been a major roadblock. Efforts to solve this problem—although still continuing—have not met with much success.

The first phase of such a program—establishment of a telemetering information and analysis center at George Washington University—so far has found no agency willing to underwrite expenses. A survey of members of the National Security Industries Association showed a considerable number of organizations with definite interest in the project—some with sufficient interest to offer to contribute financial support.

Apparently what is needed at this point is a body of some sort to pick up the project and see it through to operating status. Just who or what this body would be composed of seems a moot question.

Besides serving as a clearing house for information, the proposed center would maintain a continuing analysis of telemetering on a national scale to ascertain gaps in the state of the art, recommend new programs, and evaluate existing or proposed programs to avoid duplication of effort and unprofitable investigation.

• **Digital systems**—Typical of the uphill fight for progress in telemetry is the slow evolution of digital systems. Although many authorities agree that such systems—using pulse code modulation—have the most promising potential, evolution has been slow.

Techniques were fully developed years ago, and major subsystems have already been proved in use. It will probably be a year or more, however, before the first complete PCM system, built for the *Minuteman,* will fly in a missile. Airborne hardware development has been one problem, but the lack of coordination among manufacturers, missile makers, and range operators has been responsible for much of the lagging evolution.

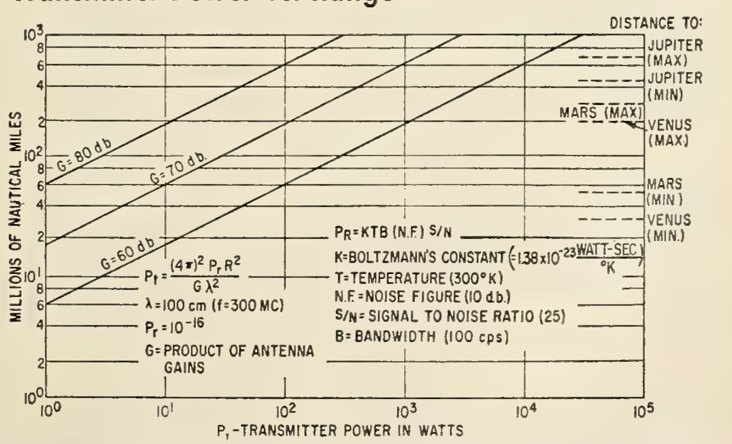
• **Re-entry telemetry**—Possibly one of the most significant advances made during the past year was the development of techniques to overcome the problems of direct re-entry telemetry. Several companies have done extensive research on this vital phase. No one claims to have found the complete solution but progress undoubtedly has been made. Transmissions have been successfully received during the re-entry phase at frequencies in the 30-50 kmc range. Other experiments in the 3-30 mc band show promise but, due to component failure, have not been fully evaluated. Research in higher-frequencies techniques leads experimenters to believe that two-way communication between earth and re-entering vehicles is a reasonable hope.

• **Transmission fadeouts**—Another problem getting increased attention has been the telemetry blackouts experienced during ascent of some ICBM's. This transmission loss generally occurs during the final boost phase and appears to be closely associated with velocity. Researchers believe that the phenomenon may be caused by partial ionization due to heat generation—similar to the re-entry problem—and attenuation caused by the rocket flame.

As rockets reach higher altitudes, the propulsion flame changes from the familiar slender pillar to an almost hemispherical shape. And, as it goes higher, the "look-angle" of the receiving antennas increases to a near vertical—in effect, they look right up the missile's tail pipe. In addition, antenna arc-over sometimes occurs at certain altitudes.

The flame fan-out is believed to change the electrical structure of the antenna and materially affect its radiation pattern. One solution being investigated is a change in transmission frequencies. Another theory is that low-

Transmitter Power vs. Range



GRAPH ILLUSTRATES interrelated problems of telemetering radio links. Interplanetary distances require high antenna gains for practical-level transmitter powers. Low power levels necessary for long-time transmitting capability make better antennas and more sensitive receivers mandatory. (Graph courtesy GE Defense Electronics Div.)

* *P. A. Borden, W. J. Mayo-Wells,* Telemetering Systems, *New York, Reinhold Publishing Co., 1959.*

	Transmitters	Receivers	Commutators Multiplexers	Converters	Subcarrier Oscillators	Discriminators	Amplifiers	Transducers	Antennas	Systems
ARF Products	X	X								
ASCOP	X	X	X	X	X		X			X
Adage, Inc.			X	X						
Adler Electronics	X	X					X			
Advance Electronics	X	X					X			
Aero Guidance	X	X								
Aerolab			X		X					
Aeronutronic	X	X								
AiResearch								X		
Airflyte			X	X						
Amelco	X	X								
American Electronics	X	X								
American Missile Prod.	X								X	
Anderson Labs.	X						X			
Antenna System, Inc.									X	
Arnoux			X	X			X	X		
Avco	X	X							X	
BJ Electronics								X		
B-L-H									X	
Beckman			X	X						
Bell Aircraft							X	X		
Belock Instr.			X	X				X		
Bendix Aviation	X		X	X		X		X	X	X
Blair Knox									X	
Bourns								X		
Brush Instr.						X	X	X		
Burroughs			X	X						
CEC				X				X		
CG Electronics		X	X	X						
Canoga	X	X								
Centronix	X	X				X				
Cleveland Met. Spec.			X		X					
Collins	X					X				
Colvin Labs.								X		
Cooper Dev.					X		X			
Crescent Eng.								X		
Curtiss-Wright				X	X					
Data-Control	X	X			X	X				X
Daystrom			X	X				X		
Dynatronics									X	X
Dorsett										X
EMR					X					
Electro Instr.			X	X			X			
Electronic Comm.		X		X	X		X			
Electro-Tech.			X							
Epsco			X	X						X
FXR						X				
Fairchild				X			X		X	
GE									X	X
Gabriel									X	
General Bronze									X	
General Devices	X	X	X	X	X		X			
General Electronic	X	X								
Giannini				X				X		
Goodyear									X	
Gulton	X	X		X			X	X		
Hallamore	X	X							X	
Hallicrafters	X	X		X						
Hoover				X	X		X			
ITT Labs.	X	X								
Kaiser	X						X			
Kauke				X			X			
Kearfott			X	X			X	X		
LEL	X	X			X		X			
Land-Air		X		X				X		
Lear					X			X		
Leonard								X		
Litton	X	X					X	X		
Lockheed	X	X							X	X
Martin										X
W. L. Maxson					X				X	
Melpar										X
Midwestern Instr.				X	X		X			
Minneapolis-Honeywell	X	X			X	X	X	X		
Moore Assoc.	X	X		X						
Motorola	X	X			X					
Mycalex		X	X							
Narmco									X	
Nems-Clarke		X								
Pacific Mercury				X	X					
Packard-Bell		X	X	X						
Ralph M. Parsons	X		X	X						
Philco	X	X		X					X	X
RCA	X	X								
Radiation Inc.	X	X	X	X	X			X	X	X
Raytheon		X		X			X			
Rheem				X			X			
Rotary Devices			X	X						
STL										X
Seeburg		X	X				X			
Servo Corp.		X								
Servomechanisms			X				X	X		
Singer Mfg.								X		
Space Electronics										X
Standard Controls								X		
Statham							X	X		
TACO									X	
TRW	X	X		X			X		X	
Taber Instr.								X		
Telechrome	X	X		X	X		X			
Telecomputing				X			X			
Telectro				X		X	X			
Tele-Dynamics										X
Telerad	X	X					X			
Texas Instr.	X		X	X	X		X			X
U.S. Science	X	X						X		
United Electrodynamics	X			X	X		X			X
Vector Mfg.	X		X		X	X	X			X
Vinson Mfg.								X		
Vitro			X	X						
Waugh Eng.	X	X								
Westinghouse	X	X								
Wiancko			X					X		

Manufacturers of Telemetry Equipment

The information presented in this chart was gathered from a number of sources: catalog and directory listings, advertisements, company literature and previous editorial coverage. In many cases, because telemetry and missiles are still young industries, areas of interest are sometimes poorly defined in relation to each other. Consequently, it is possible that some companies that should be included have been omitted. The purpose of the chart, however, is to indicate the varied types and numbers of organizations involved in radio telemetry as a vital part of our missile and space program.

ring the power output—as opposed to rute-force methods which call for ncreased power to overcome the loss —may be of benefit.

The look-angle problem may be olved by developing better receiving ntennas and more sensitive receivers nd by locating antennas to provide etter tracking angles and backup.

In any case, the period of approach-ng burn-out is a critical one in the nissile trajectory. Accurate telemetry ata is extremely important at this tage; much investigation seems war-anted to insure its reception.

• **Reliability vital**—Most experts gree that in telemetry, reliability is f transcendent importance. Other mis-sile components or systems may fail but the telemetering equipment must work at all times and under all condi-tions. Paradoxically, however, most equipment is an economic compromise. Limited funds are available to develop better systems, and no missiles are flown to test telemetry. Instrumentation is usually left until the final stages of a missile design, with the result that proven systems—although often ob-solete and inadequate—are stuffed into the bird in whatever space is left.

Reliability is receiving increased attention in this field, however, and many feel that the trend toward transistorization will be especially bene-ficial. One example is a transistorized phase-lock discriminator with a re-liability factor four to five times better than its conventional predecessor.

The trend toward transistors is becoming more pronounced in both airborne and ground systems. In ad-dition to increased reliability, reduced volume and weight are important.

• **Molecular electronics promising**—The just-arriving field of molecular electronics may also contribute signifi-cantly to reliability and space-saving in telemetering equipment. Tiny units already demonstrated can sense radia-tion and emit an r-f signal propor-tional to the impact. Such units could monitor light and heat intensity and other radiations from almost any por-tion of the electromagnetic spectrum.

Some feel, however, that costs will probably preclude use in telemetry equipment for a long time. Mass pro-duction will have to be developed be-fore molecular electronics will be eco-nomically practical for such purposes.

Considerable optimism has been ex-pressed that tunnel diodes can be used in various telemetering applications. Here again, costs are a factor; they must be reduced drastically.

The trend toward automated check-out, with its increased accuracy and reduced checkout time, will be a boon to telemetry, as will increased use of parametric amplifiers.

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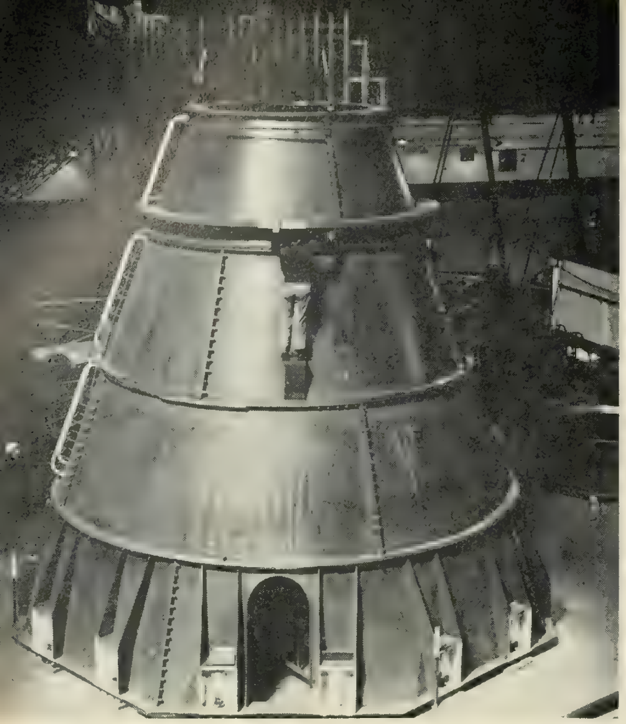
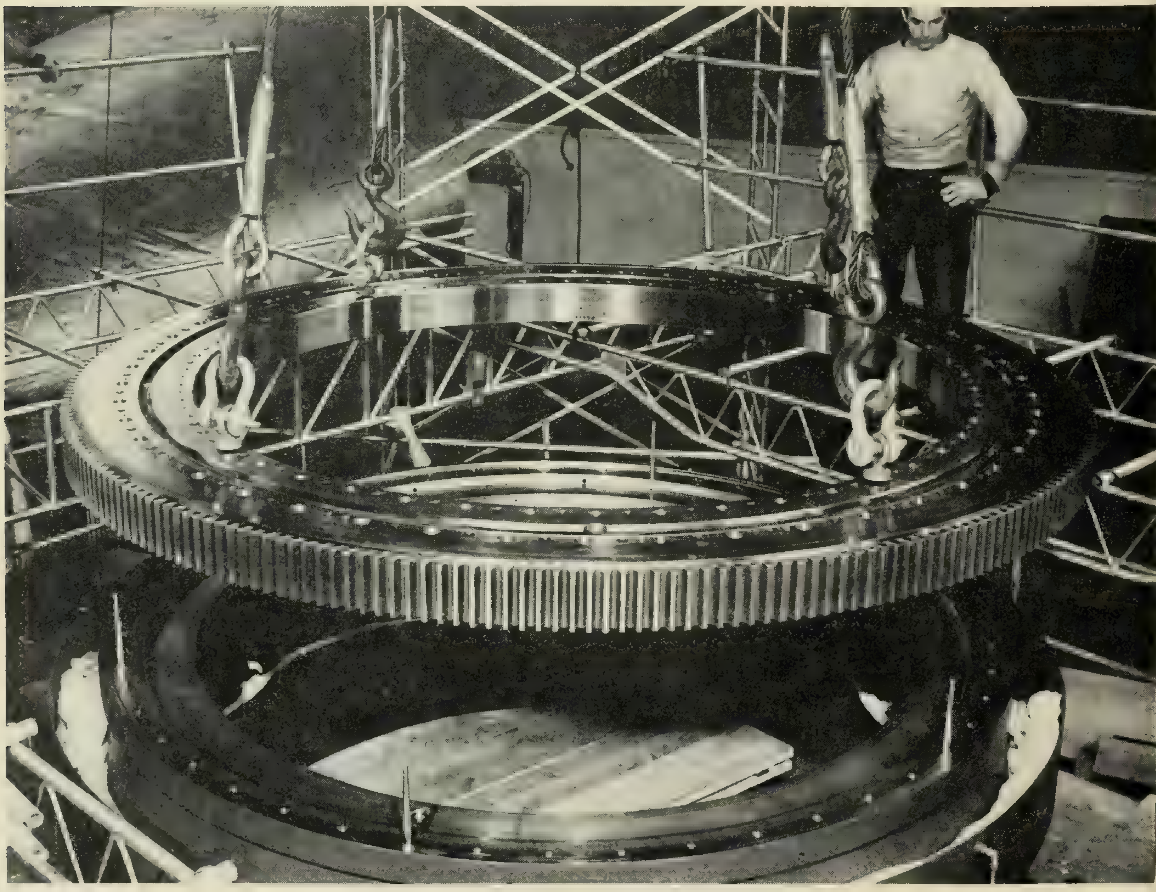


Building Antenna

Huge first structure completed by Goodyear is being tested by RCA

←

FIRST STEP is erecting the pedestal. Only partially completed here, the 50-foot high supporting structure for the BMEWS radar tracking antenna already begins to overshadow the men working on it. Goodyear used steel up to 1" thick in forming the pedestal. Entire equipment, including antenna, weighs 375,000 lbs., is one of world's largest.



or BMEWS

CONCAVE TRACKING antenna has 24-pie-shaped sections. The 400-pound aluminum sections are bolted into place one-by-one. Sections are interchangeable, augmenting system maintenance.

ANOTHER BIG task is installation of rotating gear. Here riggers lower steel ball bearing into supporting ring on which entire weight of antenna rests. Bearing is 10½ feet in diameter and weighs more than 9000 pounds. Ring weighs 10,600 pounds and 75 three-inch steel balls are nested in it.

GOODYEAR MAINTAINED close tolerance—three sixteenths of an inch—in building sections of the antenna. Two workmen are almost lost in the spider-web maze created by the aluminum mesh.

Industry Stresses Practical Engineering

Payoff shows in first-generation missiles with their high degree of accuracy and reliability

by J. Stubbs Walker*

LONDON—The outlook of the British government's research departments and industry's engineers has been "simplify, ruggedise, then simplify again." This kind of thinking has paid off in a high degree of accuracy and reliability that is not only claimed but has been test-proved in the "first-generation" missiles now coming off production lines.

With its extensive background of radar development dating back to the early 1930's, Britain's electronics industry has been well-founded to meet the challenging problems of missile guidance. There are still plenty to be ironed out, for at least two new problems crop up to every one that is solved.

But the electronic hardware now in operation on guided missiles like *Seaslug, Bloodhound, Thunderbird* and *Firestreak* is a good measure of the straightforward practical engineering approach that has underlined the governmental and industrial attitude to British weapons systems.

Security restrictions in Britain permit little to be said about the "second-generation" weapons now being prepared for production, but the broad picture is one of reasonable satisfaction, with one or two impressive breakthroughs and no mean measure of success in catching up in those fields (transistors, for instance) where America had an undoubted lead.

• **Klystron success**—An outstanding recent success is the development of the high-powered klystron, which opens up new possibilities in the illumination of missile targets with a continuous-wave beam instead of a pulsed beam. Previously, the c.w. power developed by the klystron was limited to some 200 watts, but it is said that the new tubes can handle "many times" this amount of energy. Unfortunately, information concerning precise power-handling capabilities has not been released.

Continuous-wave illumination of targets is not in itself new; it is used, for instance, in the semi-active guidance of the U.S.'s Raytheon *Hawk*. Until the development of the new tube, however, it was not possible even to approach the ranges at which targets can be indicated by pulse techniques.

The advantages of c.w. illumination are several. It is much less susceptible to countermeasure interference and the beam can be contained in a somewhat narrower frequency than the pulsed beam giving an improved signal-to-noise ratio.

Though no official indication has yet been given, my opinion is that this type of illumination may well be brought into operation with some of Britain's later weapons.

• **Tubes vs. transistors**—Most British missiles now on the production line are using airborne electronics which are almost 100% tube-operated. This is because British tube manufacturers had developed a range of ultra-rugged thermionics whose performance and reliability had been proved, whereas the failure rate of transistors under the stern environmental conditions of rockets was still to be evaluated.

Transistors, however, are now being introduced pretty generally in all but the r-f circuits of the missiles being prepared for the production line. In intermediate-frequency and control circuitry they have been tested sufficiently to show an extremely low failure rate even under conditions considerably more cruel than those normally met in actual flight condtions.

Achieving component reliability has, of course, been a considerable headache which was hardly eased by the fact that in the early days of missile development, somewhat extravagant requests were made by government departments for components made to specifications far and above those really required.

These high-flown requests, however, put the component manufacturers on their toes, with the result that both in stability and reliability, the Radio and Electronic Component Manufacturers' Federation claims, the U.K. "bits and pieces" for missile electronics are ahead of anything else in the world. It is at least significant that British specifications for the highest grade electronic components have now been accepted as international standards.

• **Thin-film**—At the London exhibition of the Physical Society in January there were some interesting examples of microminiaturisation produced by the Royal Radar Research Establishment (RRE), at Malvern, Worcs. These may well come to affect missile-borne electronics.

Though the examples were by no means approaching the ultimate in miniaturisation, they were worth noting—for with a component density of 2,000,000 parts per cubic foot RRE claims a fault rate of 0.01% per 1000 hours.

The components are in the form of thin films deposited by vacuum evaporation. Resistances consist of nickel-chromium films about 75 angstoms thick which are processed to give values up to 100,000 ohms in an area 5 mm square. Capacitors made in the form of a sandwich of thin metal films, with magnesium fluoride as dielectric, are built up to a capacity of 2000 pF at 25 volts d.c. in an area of 5 mm square.

"The immediate objective," says RRE, "is to scale down transistor circuits by at least 10:1 in both size and weight."

Transistors and diodes are fabricated on the microminiaturised circuits in flat form. One of the problems here is that of perfecting a satisfactory cir-

**J. Stubbs Walker is a writer and broadcaster, specializing in electronics and closely associated with the industry in Britain. After war service as an RAF squadron leader, he was for eight years science editor of the Daily Mail, London. Previously he was aviation correspondent of the Daily Herald and of the Sunday Times. Mr. Walker was specially commissioned by the Electronic Engineering Association in England to write this article for M/R.*

Advanced hot gas systems delivered by AiResearch

FOR OUTER SPACE, ATMOSPHERIC AND UNDERWATER STEERING

AiResearch is now in production on two greatly simplified hot gas steering control systems: a reaction control system for outer space flight stabilization and a hot gas actuator control system for terrestrial steering (in the atmosphere and under water).

Both systems eliminate any need for pumps, heat exchangers, accumulators and other apparatus required in earlier control systems. And both systems utilize hot gas, operating off either the main engine or a separate fuel source.

The gas in the outer space reaction control system is fed into a set of nozzles which imparts spin to the missile to stabilize its flight through space.

In the terrestrial hot gas actuator control system the gas is fed into an on-off controlled linear actuator which moves the fins controlling the missile's attitude in the atmosphere or under water. This system also utilizes a concept developed from the AiResearch hydraulic "printed circuit." This approach eliminates complicated plumbing, thereby decreasing the weight and increasing the reliability of the system.

***AiResearch is a pioneer,** leading developer and manufacturer of hot gas systems and other nonpropulsive power systems for atmospheric, underwater and outer space missions.*
Your inquiries are invited.

THE GARRETT CORPORATION
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cuit substrate. Present samples are on glass, but ceramic bases would be an improvement if and when materials with sufficiently smooth surfaces can be developed.

The same research unit—Royal Radar Research Establishment—has done much of the U.K. development work on infrared detectors for guided missiles—used, for instance, in the de Havilland air-to-air weapons. This has proved a fruitful line of research, and RRE has been backed up industrially by the Mullard organisation in a joint governmental-industrial approach to the problem.

Unfortunately, the indicative facts and figures on the efficiency of these devices (like so many of the other more interesting things about rocket electronics) are not available. High resolution with very small aerials is the obvious advantage.

• **Test equipment**—It is easy to focus too much attention on the actual guidance electronics of weapons, both airborne and groundbased, at the expense of the test equipment required in all phases of its design, manufacture and field operation. Reliability of the guidance is, of course, vital, but it is basically dependent on the reliability of its test equipment.

Both in Britain and the United States, there have been embarrassing situations when rockets have been pronounced unserviceable although, in fact, the fault has been with the test equipment. In the early days, in this country at least, this could sometimes be blamed on the overelaboration of test gear, particularly field equipment.

Now there has been an almost dramatic switch to simplified apparatus that can give a plain "Go—No-go" reading with 100% accuracy. (In actual operation, many of the missiles which have been test-flown at Woomera are transported for many miles over rough country *after* testing, then slung into their ramp and fired with no further attention. The failure rate has been negligible.)

In the kind of test equipment now used, transistorisation has become widely used: after all, it works under rather healthier environmental conditions than the missile-borne electronics.

Discussing testing procedures with some of the men who have been carrying out the Woomera firings, it is interesting to find that many of them believe that missiles are often *over* tested. Said one: "You go on checking your electronics until you wear 'em out. Give one quick overall test and get it in the air. Your failure rates are lower then."

Another example of test equipment requirements fulfilled by the industry is the complex electronics needed for designing, producing and testing plastic radomes. This delicate matter of overcoming problems of aberration of the radar signals to the scanner requires a whole series of operations.

First of all, computers are used to relate the dielectric properties of the material, its thickness and curvature, and the relation of these factors to the radar frequencies employed. The first thing to discover is *what* you want. Then you must find whether you have got what you want.

Finally, a "rectification set" must be used to smooth out the too-thick and too-thin sectors of the radome before a final acceptance test. English Electric reports that because of the original equipment it has produced for this work it has never yet, in a very large number of firings, had a nosecone failure.

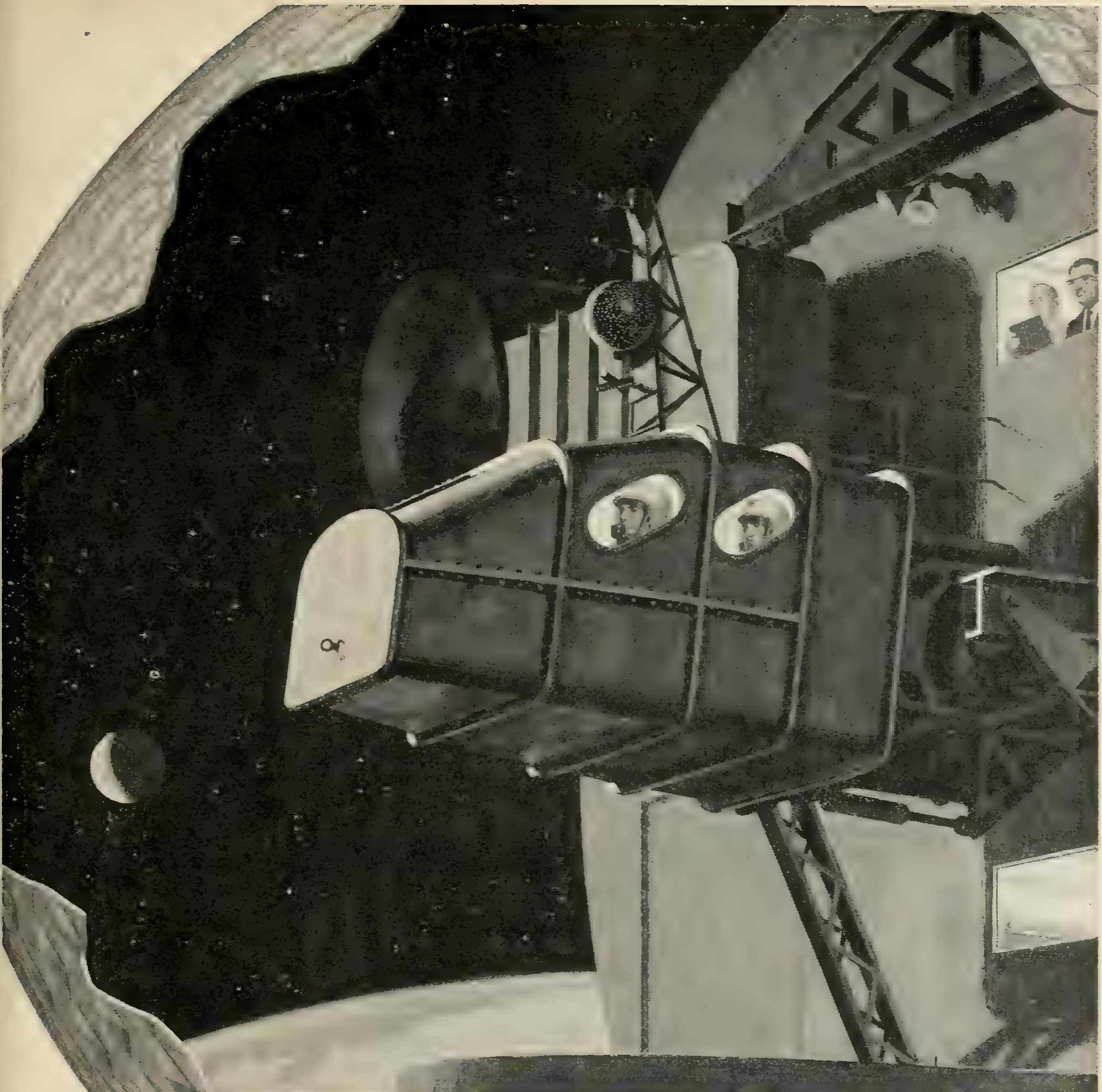
• **Price of success**—It is a pity, incidentally, that the Ministries concerned will not allow firms to announce the details of their test firings. I have recently been shown the classified figures on English Electric *Thunderbird* firings and they make good reading. The *Seaslug,* the Royal Navy surface-to-air missile, has proved so expensive on trials through the monotonous regularity with which its G.E.C. beam-riding equipment secures direct hits and destroys expensive target aircraft that the Admiralty has issued an instruction that in future trials it must be "aimed off."

Bell Develops Highly Reliable Inertial System

A highly classified inertial guidance system is being described by its developers, Bell Aircraft Corp., Buffalo, N.Y., as the most successful and reliable ". . . of any new inertial instrumentation concepts so far tested."

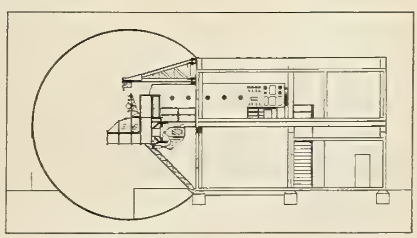
Extensive flight testing, said Bell, has indicated it to be an unprecedented high-performance system. It was designed for long-range guided missiles, satellites, and space vehicles.

The gyroscope is not considered a delicate instrument, and its maintenance and logistics requirements are low enough to make practical its application under field conditions, said the company.



A PLACE TO IRON OUT THE STRESSES OF SPACE

Seventeen different stresses will flay the minds and bodies of the first spacemen. Under the combined attack of acceleration, anxiety, heat and other stresses, how will man perform? The answer won't be known until the problem can be simulated, in all of its parameters. Vought Astronautics – a division of Chance Vought – is preparing the way with design studies of simulators like that illustrated above. Inside the laboratory's mock space vehicle, a man – without leaving the ground – would know the heat, movement, noise – and many psychological effects – of an extra-terrestrial voyage. He would glimpse a dynamic solar system and would experience, altogether, an invaluable preview of combined stresses of space flight. Vought Astronautics can produce and operate such a lab now for the development of spacecraft and the training of pilots.



From active flight instruments, motion, and a planetarium projection — a realistic preview of space flight.

CHANCE VOUGHT
DALLAS, TEXAS

Fast-Growing Semiconductor Materials

Hoffman's furnace speeds ingot production; a report on this and some gains in extraction techniques

by John F. Judge

Monocrystalline silicon ingots weighing up to 530 grams can be grown in less than 2½ hours in a new semiautomatic crystal growing furnace developed by Hoffman Electronics, of Los Angeles.

With simple modification, the furnace can be adapted to grow germanium crystals. Company spokesmen point out that the furnace's automatic features permit one person to operate four units simultaneously.

The automation sharply reduces the human error factor, since each operating cycle including pre-gas, meltdown, pulling and drawing, is push-button controlled. The speed of the seed rotation, withdrawal, time cooling rates are also rigidly controlled.

A radiamatic pyrometer keeps the furnace temperature to a preset value. An elaborate system of monitors constantly checks inert gas pressure, cooling system and the power requirements, flashing a warning when failure occurs.

Each of the mechanical parameters can be operated independently of the others. The operator can select crucible position, rotation, seed rotation, and pull rate as needed.

ZONE MELTING applied to a rod of powdered boron. A method for coating boron powder with boric acid made it possible for Bell Laboratories to process strong, pressed forms of boron.

The furnace incorporates the widely used Czochralski method—seed drawn ingots—and utilizes a specially developed resistance heating system.

The product of this instrument is the basic building block of the rapidly growing semiconductor industry—an estimated $510 million market in 1960. There are over 100 major U.S. firms producing transistors, diodes, rectifiers and infrared detector cells from silicon and germanium ingots.

• **Getting materials**—The separating of the two major raw materials, germanium and silicon, from their natural states is just the first step in a highly developed art that results in the starting products for the semiconductor industry.

Initially, germanium is recovered from the zinc, lead, and copper industries. Sylvania Electric Products takes recovered germanium tetrachloride, hydrolyzes it to the oxide and then hydrogen-reduces it to elemental germanium in the firm's Chemical and Metallurgical Division.

Other major producers such as American Zinc, Lead and Smelting Co., and American Metal Climax Inc., are engaged in the extraction of this element by various processes.

The common source of elemental silicon is the reduction of the tetrachloride by hydrogen.

The most important part of semiconductor starting materials production is the refining and purifying stages. To be effective, the germanium and silicon must be of such high purity that ordinary methods of analysis cannot be employed in checking and grading. Instead, the purity of these substances is measured electrically and expressed in terms of resistance per cm.

• **Zone melting**—In 1952, William G. Pfann of Bell Telephone Labs Inc. discovered the process of purification by zone melting. Today this method, with various extensions, is the standard means of refining germanium and silicon the world over.

Zone melting is based on an old principle used in fractional crystalliza-

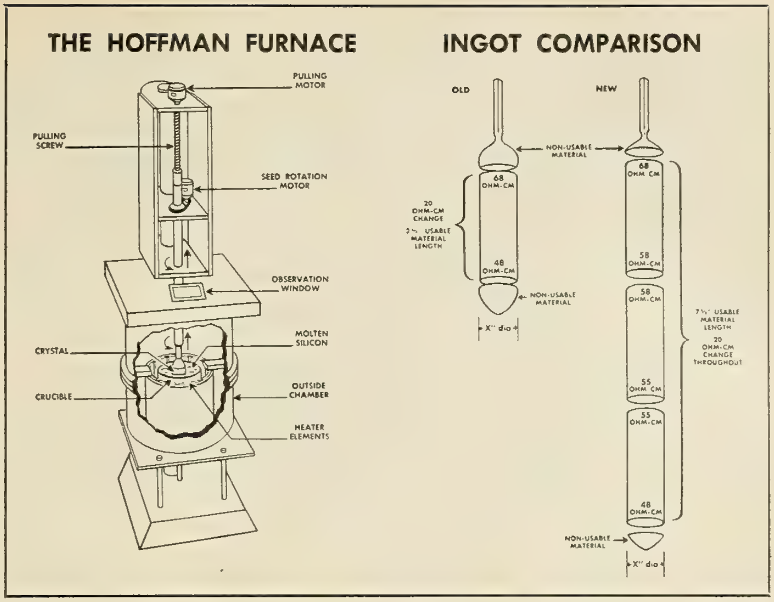
tion—the composition of a freezing crystal differs from its liquid. Pfann combined this with the passing of a short molten zone through a solid and came up with the process that, among other things, can distribute a desired impurity uniformly through a single crystal and make precisely controlled discontinuities in impurity concentrations. These discontinuities are the familiar p-n and n-p-n junctions in semiconductors.

The nature of the process is readily understood if one follows the molten zone through a solid containing impurities. If the impurities raise the melting point of the solid in the molten zone, they will travel in a direction opposite to the passage of the zone. If they lower the melting point, the reverse is true.

• **Variations**—There have been many variations on the basic theme by Bell Labs. There is temperature-gradient zone melting, wherein the zones are very small and are made to move not by a traveling heat source but by a temperature gradient impressed across the entire range of the melt.

The floating zone technique, first applied to silicon, involves the moving of a molten zone vertically along a bar grasped at either end. The zone is held in place by its own surface tension. This limits the size of the ingot to be purified but eliminates contact with a "boat" or crucible which usually introduces impurities, especially in refining silicon.

An improvement in this latter method was announced last year by Bell Labs. It consists of using specially shaped cross-sections—such as flat plates and tubes. This allows the melting of a thin cross-section without exceeding the surface tension effect, while increasing the total cross-sectional area treated by enlarging the width of the zone.



These techniques are catching on in areas far removed from semiconductors. They have been applied in metal purifying, organic and inorganic separations and even with water. The Russians recently announced the use of zone melting to purify water, alcohol and HCl through liquid air and other cooling methods.

• **Cutting boron content**—Boron is the only element that cannot be removed by zone refining—and it is one of the important contaminants in electronic silicon. Sylvania has been able to reduce the boron content from four to one part per billion and sometimes as low as three parts per ten billion and lower. The firm had been reducing silicon tetrachloride in process involving gaseous zinc. Substitution of hydrogen for zinc resulted in this decrease in boron content because of the relative ease of purifying hydrogen.

The stringent requirements of the electronic apparatus being produced now and in the near future have kept the supplier's laboratories hopping. The recent Westinghouse development in molecular electronics (M/R, Feb. 8, p. 22) is illustrative of the coming improvements in this field.

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ingenious approach . . .

Summers Produces an Expendable Gyro

by William J. Coughlin

SANTA MONICA—A new lightweight gas gyroscope appears to meet a long-sought need for small expendable units in military missiles.

Developed by Summers Gyroscope Co., this simplified gyro system has proved to be extremely reliable during eight months of test operation. Three-inch diameter units will provide up to 30 minutes running time, according to the Summers Company.

The gyro employs one of the world's oldest principles to provide a stored-energy system. But, where other gyros have used a stored propellant of some sort, ingenious use has been made of pressure differential to provide energy.

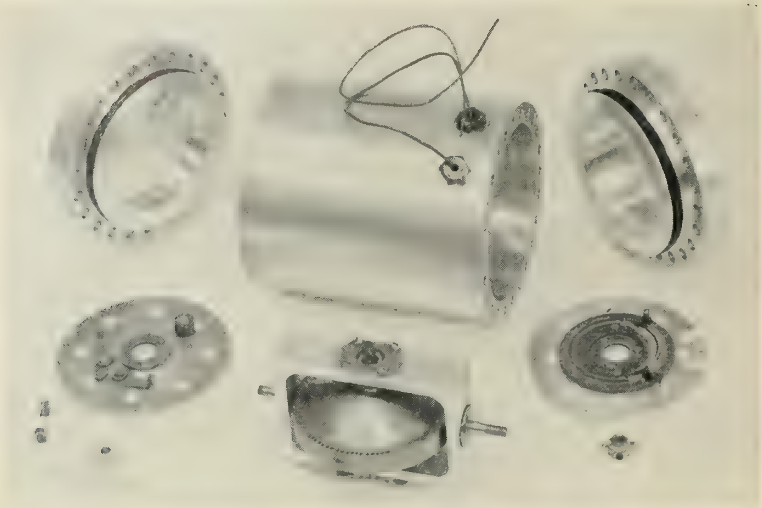
The gas gyroscope consists basically of a hollow rotor which has a number of equally separated open jets. The rotor is installed within a chamber which can be pressurized and is equipped for fast pressure release.

When pressure is released, the compressed gas escapes through the rotor jets and its stored energy is converted to angular momentum.

The gas gyro has several important characteristics:

• It is not burdened by electrical or mechanical power couplings through the gimballing system to the rotor.

• It is capable of an indefinite number of charging and discharging cycles



PROTOTYPE RATE GYRO developed by Summers Gyroscope operates at 2000 psi. Rugged, but inexpensive, a 3-in. dia. unit will run for nearly 30 minutes on discharge cycle. Disassembled view indicates simple construction.

without conventional wear.

• Even if a shroud or other jet-stream deflecting device is not employed, it will not exhibit conventional "case-erection" tendencies of other types of fast-accelerating gyroscopes.

Birchard H. Ford, associate research director in the new products division, says weight of the new gyro generally is less than that of other gyros performing the same functions and it is cheaper and more reliable. Also, there are fewer parts than in a conventional gyro.

Thirty minutes would appear to be the practical limit at the moment for a 3″ gyro," Ford says. Research on coasting times indicates this could be extended somewhat, but would require more expensive bearings.

As planned, production cost is expected to be about one-third that of a spring-driven gyro designed to meet the same general requirements. (Summers builds conventional gyros for several U.S. missiles, including *Lacrosse* and *Bullpup*.)

• **Applications**—According to Ford, the gyro can be used in any application where a spring-loaded or energy-stored gyro can be used. The principle can be employed in vertical, free or rate gyros. A prototype rate gyro has been under test at Summers since last May.

In one application of the gyro, an electrical squib provides a shock wave which simultaneously uncages the gyro and breaks the diaphragm to allow escape of the gas from the outer chamber. Discharge also could be accomplished mechanically.

During pressurization of the case, the gas enters the rotor through the jet ports. Thus, no slip rings, pneumatic piping or other weight-increasing devices are needed.

In the fully-charged condition, pressure within the rotor is the same as in the case. If maximum accelerating speeds are not necessary, pressure can be released slowly from the case through a retarding orifice so that the rotor itself does not have to be designed to withstand the full pressure differential, achieving a weight-saving.

For example, if the case were to be pressurized to 2000 psi and the pressure released so that the rotor and the case were discharging at about the same rate, the rotor would not have to be subjected to more than a fraction of the initial 2000 psi.

Efficiency of converting the energy within the rotor to angular momentum would be the same in either case, Ford notes. Only essential difference lies in time required to achieve final momentum.

In an application where the gyro can be uncaged after reaching speed, a shroud can be employed to provide 35% more energy. When firing is desirable uncaged, however, elimination of the shroud means very little case erection tendency because there is little impinging on the gimbals.

Efficient rotors can be designed which will reach approximately 88% of maximum operating speed within one second, Summers reports. Rotor reaches full speed within two time-constants, which can be computed from size of the jets. Prototype testing indicates that optimum jet size gives a minimum time-constant of the order of one second.

A spherical rotor is employed to keep all weight not contributing to momentum to a minimum. Only light gimbals are required since no power couplings are needed through the gimbals.

• **Design parameters**—Energy obtained is a function of the diameter of the rotor to the fourth power. Thus, on extremely small applications, the point is reached where more energy might be obtained with a spring-driven gyro.

Ford suggests this is true in areas where gyros smaller than ¾″ diameter are desired. Even here, he notes, the gas gyro might prove better due to better shock qualities and other advantages.

Gyros with diameters of 3 in. or greater are quite easily designed for this application, according to Ford.

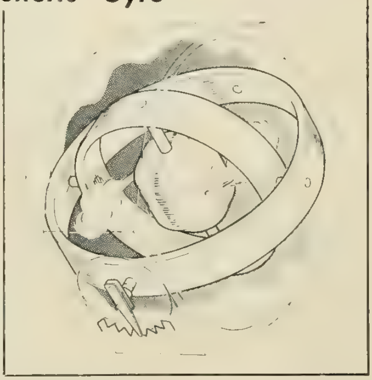
Gas employed could range from compressed air to the more exotic gases, it is reported. Ford says all known requirements can be met with the use of nitrogen at 2000 psi.

More extreme requirements could be met by a change to some of the denser inert gases when pressure increase must be avoided, or by use of filament-wrapped cases when 5000 psi or higher is required

Summers reports the gyro can stand more shock than conventional gyros because the rotor and gimbaling systems are lighter. Rotor can be brazed or welded thin-shell steel construction. Fine machining is required for the precision jets. An aluminum cylinder with end plates provides the outer casing. Volume exterior to the rotor can be held at a ratio of 1=1 or less.

Summers estimates that gyros of 3″ diameter or larger can be produced in quantity for around $100 each.

Shorts' Gyro



FREE GYRO used in Short *Seacat* anti-aircraft missile will be made under license in U.S. by Giannini Controls Corp.

slightly misnamed . . .

3-D Radar Grows in Importance

Survey of varying approaches indicates there probably is no single 'best' design

ARMY'S AN/MPS-23 radar (Hughes FRESCANAR) is representative of 3-D radar systems. It simultaneously detects range, bear-ng, and altitude of supersonic targets, computes information, and transmits to guided missile batteries which launch weapons.

by Hal Gettings

Three-dimensional radar is becom-ng increasingly important in detection of high-speed aircraft and missiles. Sys-ems delivered and those still in the de-ign stage are aimed at providing in-tantaneous data to interceptor control operators and automatic defense sys-ems.

Primary feature of the 3-D equip-nent is simultaneous measurement of all three parameters of target position —range, altitude, and azimuth—with one system, for faster evaluation of en-emy aircraft and missiles.

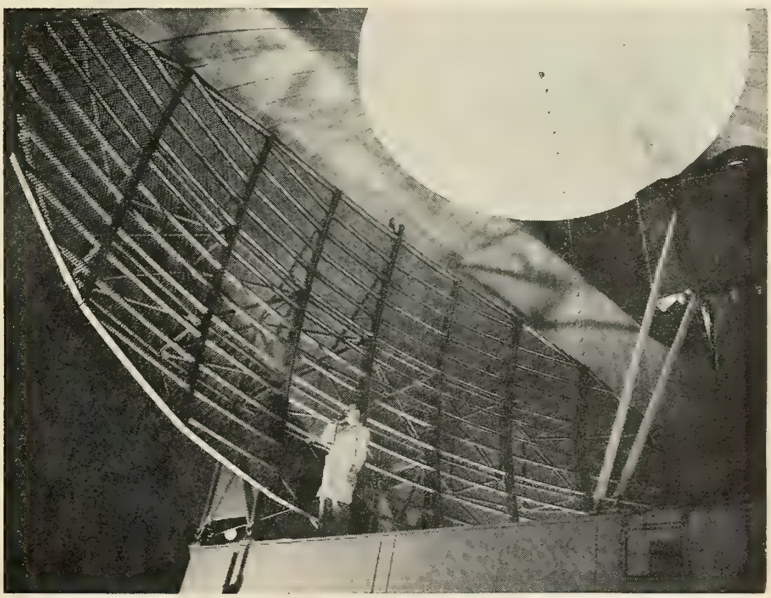
Previous methods required two sep-arate radars: one for range and azimuth, and another for height-finding. Problems of synchronization, time de-ays, equipment multiplicity—with at-endant maintenance and spares head-aches—and other complications often make this method undesirable.

Actually, the designation "3-D" is not entirely correct. Although data is furnished on three dimensions, presen-tation of the data requires two different scopes. One is a conventional PPI—plan position indicator—which shows the horizontal relations of the target: azimuth and range. The other is the height-finding, or elevation, indication which shows the vertical sweep of the radar beam.

General Electric is reportedly work-ing on a true three-dimensional presen-tation of target data, but details have not yet been released. It is assumed that methods similar to those used in the development of the 3-D oscilloscope would be used in the radar display.

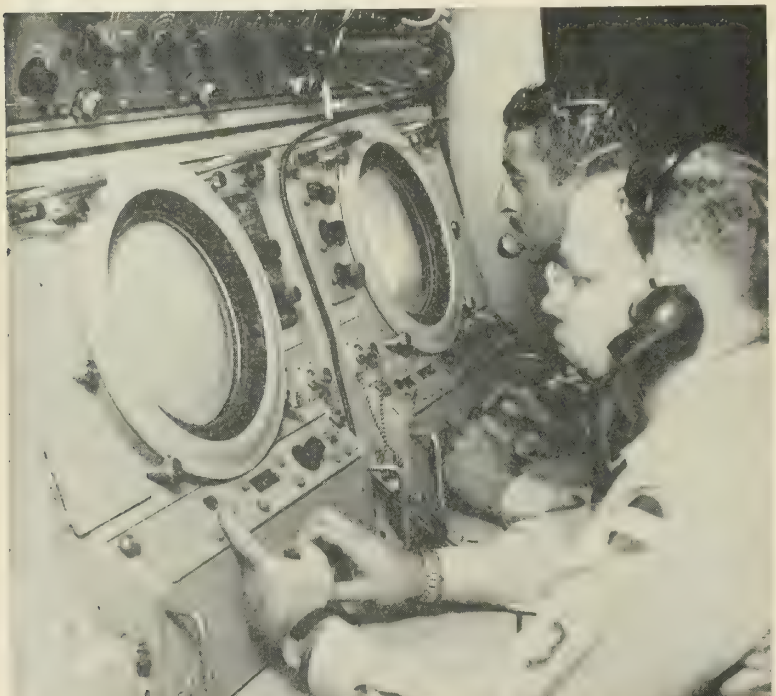
• **Different techniques used**—As yet, no one has come up with one best way to design a 3-D radar. There seem to be as many ways to do the job as there are designers—and each feels that his way is the best. However, other factors —size, power, mobility, application— enter into the question; there probably is no one simple solution.

One of the first techniques used in an operational system was the "V-beam." Two fan-shaped beams from the same antenna—related to each other



SUPER-SENSITIVE ANTENNA of GE's AN/FPS-7—new long range, multi-beam air defense radar—measures 40 by 18 feet and just fits inside a 50-ft. radome. The white circle at top reduces the concentration of heat from the banks of de-icing lights, and permits uniform melting of snow and ice on the outside of the radome.

CUTAWAY DRAWING of TPS-27 shows painted-on antenna (gray area in center) in inflated Paraballoon. Entire system is enclosed in pressure-inflated radome approximately 50 feet in diameter.



FRESCANAR scope on left displays target range and bearing, that on right, altitude. Data is instantaneously transmitted to missile antiaircraft batteries which automatically track targets. Hughes' "3-D" system requires only one antenna and one master console as compared with conventional types which require two or more.

in somewhat the same way as the arms of a "V"—provide indications of the three target parameters. As the antenna rotates, an automatic computer determines the height and range of the target by measuring return echoes picked up by the vertical and slant beam reflectors in relationship to the angle between the two and the time between echoes.

At least two systems use the "stacked-beam" technique. This method uses one transmitter and one frequency and a number of receivers, according to the number of individual beams. In essence, the antenna pattern describes a vertical fan-shaped beam covering most of the vertical quadrant between 0 and 90 degrees. This beam is composed of a number of separate beams which partially overlap. Relative strengths of reflected signals received by the various beams determines the elevation angle (and altitude) of the target.

Advantages of this technique are extremely fast determination of target position and long range. It requires more power than some other methods.

• **Hughes system**—Hughes Aircraft claims to have produced the first practical 3-D radar. Its development—called FRESCANAR and designated AN/MPS-23—is part of the Army's Missile Monitor defense system. Units were delivered over one year ago. First versions of the radar were developed for the Navy for use aboard ship.

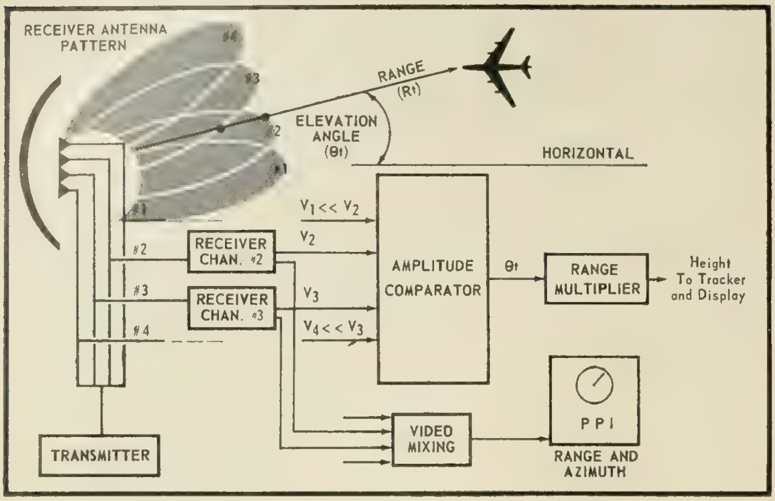
As used in the Missile Monitor, the MPS-23 feeds radar-detected target information to a radar processing center, which converts visual target data to digital information and sends it to various units of the defense system.

In the frequency-scanning technique, the antenna and feed remain fixed with respect to the vertical. Scanning for elevation angle data is accomplished through electronic switching of the beam angle by changing the frequency. The beam, therefore, sweeps up and down at an extremely fast rate —much faster than mechanical scanning. Scanning is programed by digital means to occupy precisely these successive positions in space calculated to yield maximum accuracy and coverage.

• **Sperry system**—One of the early systems to provide three-dimensional data at extreme ranges, Sperry's MPS-21 was delivered to the Marine Corps last November. This is a highly portable tactical early warning system designed to detect high-speed aircraft and missiles. It is transportable by helicopter and can be set up within two hours.

The MPS-21 uses a V-beam antenna pattern configuration. Search and height-find radar paraboloidal-shaped reflectors are superimposed on a single antenna. The face of each reflector pro-

designed for mobility . . .



duces a composite, simultaneously transmitted radar beam which consists of a vertical beam for search and a slant beam for height-finding. Each surface of the antenna is fed by a separate horn, and two additional horns are used to receive the reflected signals. Targets passing through the two beams yield range, azimuth, and altitude data to the combat interceptor control. Horizontal scan speed is six rpm.

Designed for mobility, the system is packaged in cases that can be man-carried or assembled on pallets for transport by air or land vehicles. The assembled system is covered by a light-weight inflatable radome which makes it possible to use the system in any climate.

• **SAGE uses FPS-7**—Radar data for the SAGE continental air defense system will be provided by the General Electric FPS-7 radar. Recently delivered to the Air Force Air Defense Command, this unit is the first in a series of high-power multibeam systems for detection of aircraft at high altitudes and extreme ranges.

According to GE, the FPS-7 provides much faster target data on approaching aircraft than is possible with the conventional system. This data is relayed to the computers instantaneously, eliminating the present interdependence of one radar on another and speeding up the calculation of intercept data. This factor is increasingly important in this age of high-performance, long-range supersonic aircraft when human errors or excessive time in computation of radar data and the transmission of weapon control commands could be disastrous.

The FPS-7 features a unique "varifocal" antenna design. It operates on a multi-beam—or "stacked-beam"—principle whereby several narrow beams are fed to the antenna, as compared with the standard single broad-beam method.

Radio-frequency power for the FPS-7 system is generated by a five-foot high Klystron tube jointly developed by the Rome Air Development Center and General Electric. This multi-megawatt tube produces hundreds of times more power than the radar that was used to beam pulses to the moon and back in 1946. Its frequency limits can be held much closer than the frequency limits of conventional radio and TV transmitters.

A super-sensitive antenna, which weighs approximately seven tons and rotates 360°, focuses the high-power pulses of r-f energy emitted by the FPS-7. Its reflector measures 40 by 18 feet.

In addition, the FPS-7 includes 52 cabinets of electronic equipment. Printed circuitry and plug-in type units have been used wherever possible to simplify maintenance and increase system reliability.

The overall system is housed in an Arctic Tower with a 50-foot air-inflated radome to protect the antenna from wind, snow and ice. The radome is designed to withstand winds in excess of 100 mph. It is fabricated from neoprene-coated Nylon fabric in the shape of a ¾ sphere 55 ft. in diameter.

• **Westinghouse model**—The Westinghouse entry in the 3-D sweepstakes is the TPS-27, now in production. Built by the Electronics Division under a contract with Rome Air Development Center, this is a medium-range tactical system. Its primary feature is easy mobility—it can be set up and operating within four hours. The prototype system has been delivered to the Air Force for a comprehensive test program. The first of eight production models is scheduled for delivery in October, 1961.

The TPS-27 uses a "stacked-beam" technique to provide simultaneous height-range-azimuth information for input into automatic defense systems.

A unique feature of the Westinghouse radar is the 30-foot Paraballoon antenna used. Contributing to system mobility, the Paraballoon is lighter and more accurate than a conventional metal counterpart. Inflated and kept erect by low-pressure air, the antenna is precise to one-eighth wavelength. Dimensional stability is no problem. The reflecting surface is a silver-impregnated coating painted on the interior of one side of the oblate Paraballoon. The other side is transparent to r-f energy and serves as a supporting structure.

• **BMEWS radar 3-D**—The BMEWS detection radar—with its 3000-mile range—can also be classified as a 3-D system, in a different sense. Its "radar observer," called DRDTO (Detection Radar Take-off subsystem), estimates azimuth as well as range and velocity.

Emphasis Shifts to R&D of Components

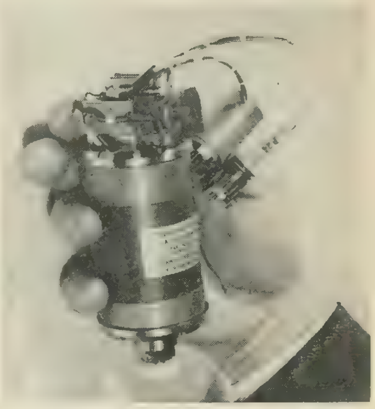
by W. G. Wing*

Progress of inertial guidance directly depends on progress in development of gyroscopes and accelerometers. Consequently, intensive emphasis is being applied to research and development of these vital components. Accuracy and reliability are the two primary goals.

All inertial guidance systems require high-quality gyroscopes and accelerometers. In general, short-time operations emphasize the need for excellent accelerometers; long-time operations emphasize the need for excellent gyroscopes. To illustrate, in the case of a 5000-mile ballistic missile, an error in velocity measurement of one foot per second will cause an impact error of one nautical mile; because the missile velocity is some 18,000 feet per second, the required accuracy is 0.005%. Achieving this accuracy of velocity measurement is fundamentally dependent on accelerometer performance.

In the long operating time applications (such as cruise missiles), the rotation of the indicated vertical is measured with respect to the system gyroscopes. For this reason, any angular drift of the gyroscopes becomes directly a corresponding error in knowledge of position. If the gyroscopes drift at a rate of 0.016 degrees per hour, the position error will increase at a rate of one nautical mile per hour; this should be contrasted with the 5 to 10 degrees per hour drift which is normal for conventional aircraft instrument gyroscopes.

• **Gyroscopes**—Although gyroscope performance requirements differ markedly for different applications, all but the crudest require instruments of high quality. The excellent drift requirements of long mission time applications have previously been indicated; ballistic missiles permit relatively high drift rates but the required performance must be attained in a very troublesome acceleration and vibration environment. A ballistic missile, therefore, requires extreme mass balance accuracy and excellent isoelasticity (uniformity of rigidity in various directions).



INTEGRATING accelerometers ("space speedometers") measure velocity in three-dimensional space for inertial guidance stable platforms. Newest type developed by Sperry employs a spinning liquid instead of bearings to avoid friction errors and provide extreme accuracies.

A multitude of error sources must be considered in the design of inertial guidance gyroscopes. These include suspension friction, dimensional stability, effects of temperature, (variations of value and of gradients), magnetic field susceptibility, and isoelasticity.

The most obvious variable among gyroscope designs is the form of the suspension. The most common method of suspension for inertial guidance use is liquid flotation (with some supplemental means to establish axes of rotation). Flotation can reduce friction levels to complete negligibility and at the same time impart excellent resistance to shock and vibration. The density of the moving element is limited to that of the liquid used—and this limits the angular momentum and structural rigidity. Also, liquid-floated gyros must be constructed with extreme care to avoid contamination of the liquid or the presence of gas bubbles.

Hydrostatic bearings using gas under pressure have been employed for some time. With very careful design and fabrications, very low uncertainty torque levels are possible. The major drawback of this method of suspension is the need for a continuous supply of almost absolutely clean gas. In addition, very high tolerances are required in parts manufacture and very clean assemblies are necessary. On the plus side, the suspension method permits use of a high-density moving element and, hence, high rigidity and angular momentum.

The old standby of the control gyro field, the ball bearing gyroscope, is almost unknown in inertial system design. One recent design, the Sperry Rotorace gyro, shows promise for inertial applications in which high reliability and short warm-up periods are more important than extremely high orders of accuracy.

Both single and two-degree-of-freedom gyros are used (a single-degree-of-freedom gyro gives information about only one rotational axis while a two-degree-of-freedom gyro gives information about two axes at right angles). The single-degree-of-freedom design is the more commonly used; it has an advantage in that it requires extreme mass balance, isoelasticity and thermal symmetry in only two dimensions instead of three. On the minus side, it allows significant disturbances in the orientation of the spin axis under angular vibration. This leads to drift error. In addition, three single-degree-of-freedom gyros are needed for a complete directional reference system whereas only two two-degree-of-freedom gyros are needed.

Current gyro designs differ in a number of details; among these are:

• Degree of damping (in single-degree-of-freedom types).

• Nature of spin axis bearings.

• Suspension used to supplement flotation (e.g. jewel pivot, magnetic, flexural, hydrostatic).

ABOUT THE AUTHOR

**W. G. Wing, a leading authority on inertial guidance, has specialized in the design and development of inertial systems and components at Sperry Gyroscope Company for the past 10 years. As manager of inertial systems products in the Air Armament Division for aerospace applications, he is in charge of advanced design as well as the product engineering and technical sales aspects of this work.*

• Nature of angle pick-off.

• Nature and accuracy of torque generator (both ac and dc types are used with accuracies varying between .01% and 1%).

Successful inertial gyros have been built around all of these variations, but none of them enjoys a clear lead. Most applications, though, use the highly damped single-degree-of-freedom type. This has already been found suitable for all but the most severe guidance uses proposed.

• **Accelerometers**—With few exceptions, inertial guidance accelerometers are basically pendulums kept centered by some type of torque feedback. Suspension methods include all of those previously noted for gyros, with flotation and flexural types the most common. Devices using flexural suspension tend to be more simple and compact but are subject to null errors due to imperfect coincidence between the zero torque angle of the suspension and the zero single angle of the pick-off.

Several available accelerometer designs use moving coil, permanent magnet field devices for creating the force or torque feedback. The best examples of this form give accuracies in the order of 0.01%.

In other pendulous accelerometers, the torque produced by acceleration of the pendulum bob is balanced by the torque required to change the angular momentum of a wheel. Because the rate of change of angular momentum of a body is exactly proportional to the applied torque, this principle can lead to extremely accurate accelerometers. Designs of this general class take two basic forms: the pendulous gyro accelerometer and the kinetic doubly-integrating accelerometer.

In the pendulous gyro device the pendulum torque is balanced by gyro precession torque. The output is a shaft angle proportional to the first-time integral of the acceleration. In the kinetic doubly-integrating accelerometer, the pendulum torque is balanced by the acceleration torque of a flywheel. Its output is a shaft angle proportional to the second-time integral of acceleration.

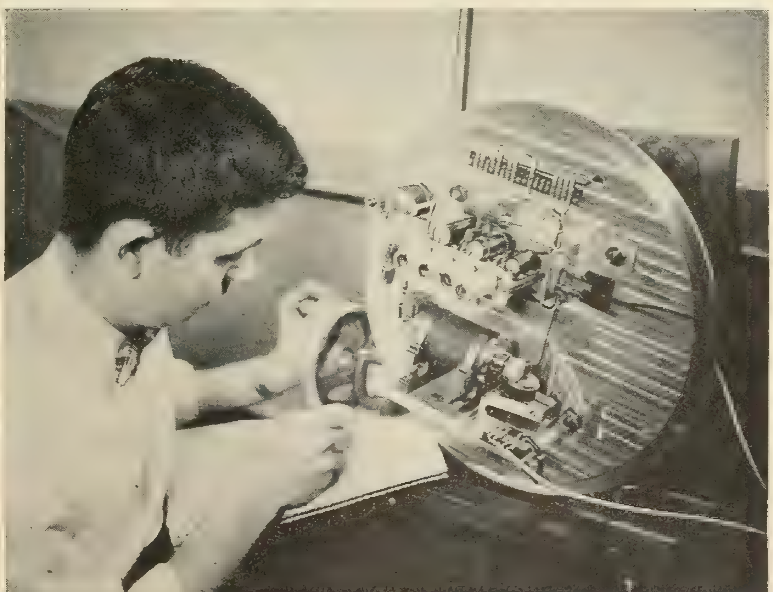
When vehicle velocities are very high, the gyro type is the better of the two; for low velocities, the kinetic, doubly-integrating type is quite satisfactory. Because of the inherent accuracy of the torque balance principle, both instruments can be highly accurate (substantially better than 0.01%). The chief error source is due to uncertainties in the degree of pendulousness.

Vibration causes errors in all pendulous accelerometers. Such errors can be controlled either by providing very great dynamic restraint on the pendulum or by making the pendulum arm long. Ideally, the pendulum should be of infinite length. For obvious reasons, only the use of great dynamic restraint is practical; in some designs this takes the form of viscous damping; in others, very high servo loop gains are employed; in some designs the natural frequency of the servo loop has been pushed up to the region of 1000 cps for this reason.

One accelerometer design which does not fall into any of the classes so far indicated uses a low-density test mass suspended in a body of viscous liquid. By spinning the liquid body, the test mass is forced to remain on the axis of spin. Under acceleration along the axis of spin, the test mass moves through the liquid at a rate proportional to the acceleration. The total displacement of the test mass is a measure of the first time integral of the acceleration.

The most commonly used accelerometers in inertial guidance systems are

INERTIAL guidance systems—such as this model for the *X-15* rocket plane shown on the "stable table"—receive exhaustive tests to determine accuracy and reliability.



SPECIAL ultraprecise indexing platforms have been created to measure accuracy of new integrating accelerometers at any point throughout full 360 degrees. Master table automatically compares response in any position with correct answers, exact within plus or minus 1.5 seconds of arc.

pendulums using either moving coil dc torque motors or the pendulous gyro principles. It is still not certain, however, that any of the types is clearly superior; other types are also under development which may prove to be superior to any thus far used.

• **Servo requirements**—Stable platform servos in inertial guidance systems must be of very high performance if high guidance accuracy is to be achieved. Fortunately, available techniques can provide the required accuracy.

The need for great accuracy results from two factors. For one thing, the gyros must be kept nulled to within a very few seconds of arc if good drift performance is to be obtained. For another, the accelerometers must be angularly stabilized with great accuracy if the direction of the measured acceleration is to be accurately known.

To achieve the required servo performance, direct drive (ungeared) servos have been commonly used. Use of direct drive motors eliminates the loop stability problems caused by backlash, reduces friction torques on the platform axes and eliminates the disturbing effect of the reflected inertia of servo motors and gear trains.

Direct drive motors are inherently low-efficiency devices, although the dc types are much more efficient than their ac counterparts (for this reason dc direct drive motors are the more common). Furthermore, direct-drive dc motors tend to be low-voltage, high-current devices. In early systems these characteristics resulted in serious control amplifier problems; power transistors have now largely overcome this problem.

• **Computers**—The first inertial guidance systems used analog computers exclusively, but digital computers are now becoming more common and can be expected within a few years to almost completely displace the analog computer. Despite the evident coming dominance of the digital computer in the inertial guidance field, it is probable that for the simpler, less demanding applications, the analog computer will remain useful.

• **Mixed systems**—Although inertial guidance can be performed without auxiliary equipment, it is frequently advantageous to provide information derived from other sources. For instance, for relatively long airborne missions, gyroscopes are not available which, within acceptable size and weight limitations, will provide the desired accuracy. Stellar inertial systems utilize information derived from star tracking to correct for gyro drift and hence give accuracy independent of mission time. In some instances, the star tracker is used only to provide heading information; in this case, only one body need be tracked—and this can be the sun during daylight hours and a star at night.

Doppler inputs can be used to provide for damping of oscillations (84-minute period) which are inherent in inertial systems or can be used as the primary source of velocity information. In the latter instance, the inertial system provides heavy filtering for doppler system noise and provides the higher frequency information or vehicle motion.

• **Other factors** — An important aspect of inertial guidance is its invulnerability to jamming and its independence of ground-based aids which might limit its range; these are, of course, particularly significant for military uses. Military applications have fostered the intensive development of inertial guidance despite very real prob-

lems of cost, weight and reliability.

The high cost of inertial guidance equipment results from the extreme tolerances required in parts, the great care required to assemble the parts and the extensive testing required to perform calibrations and assure quality. High cost thus relates largely to the amount of highly skilled labor which must go into each system. It is improbable that costs will come down a great deal unless component designs are developed which inherently give high accuracy with much less detailed work.

Reliability is also very much related to the extreme exactness required throughout an inertial guidance system to provide useful accuracy. In other words, a system can be operating in every detail but a small deterioration in performance may reduce the accuracy to an unacceptable level. Here, again, the most hopeful means of improving the situation is development of designs in which suitable performance is more inherent.

A great improvement has been made in weight during the past decade. Systems built in the early '50s tended to tip the scales in the one ton (or more) region. Present systems weigh a few hundreds of pounds and future systems (of good accuracy) can be expected to weigh in at well under 100 pounds.

• **The future**—It is almost universally accepted by designers of inertial equipment that new basic components are needed for inertial systems use; intensive efforts are being made to develop such components. As has been indicated previously, new components inherently capable of better performance should greatly reduce cost, improve reliability, reduce weight and, of course, improve accuracy.

Work is going on, for instance, in the electrostatic suspension of gyroscope rotors, cryogenic gyros and nuclear spin gyros. It is not yet certain that any of these is truly practical, but all are hopeful. There are other approaches which do not seem nearly as exotic but which may, ultimately, prove practical. It may be expected, for instance, that gas lubricated spin bearings will soon be in practical use.

• **Space applications**—The expected peculiarities of space travel obviously will present particular problems. During an early boost phase, the basic guidance would not be markedly different from that for a ballistic missile, but after initial boost the problem becomes quite different. For one thing, mission times become exceedingly long —achieving low gyro drift angles would be extremely difficult. Under weightless conditions, many sources of gyro drift would vanish.

Space Instrumentation Growing Up

Space instrumentation, the baby business of the electronics industry, is going to be given a very expensive diet to grow by in 1960.

Estimates are that the National Aeronautics and Space Administration will spend over $150 million during 1960 for satellite instrumentation, ground telemetry and tracking units, computers, and for the station-linking communications systems.

Specifically budgeted for space instrumentation and related fields in NASA's supplemental FY '60 budget and the FY '61 budget is $116 million. This does not include the $141 million in both budgets for Project *Mercury*, and NASA witnesses told Congress recently that communications is the largest single line item in that budget.

Construction and equipment items in the two budgets include: $9,500,000 for the construction of the NASA space communication center at the Goddard Space Flight Center; $4 million for vertical probe (sounding rockets) telemetry and tracking facilities at Wallops Island; $22 million in both budgets specifically for the *Mercury* tracking network; $8 million for the deep space network; and $4,750,000 for the Minitrack satellite tracking network.

Research and development items in the two budgets include: $20,700,000 for meteorology satellite applications, $5,600,000 for communications satellite applications; and $32,550,000 for tracking and data acquisition. The latter category is broken down into two items: $25,530,000 for operative communications and utilization, and $7,220,000 for advanced technological development.

An important part of NASA's space instrumentation program never leaves the ground. It involves the great amount of tracking and data acquisition equipment that must be built before man can go into space, and instrumented payloads can be tracked in deep space. This program is funded for $64,300,000 in the FY '61 budget.

• **Program by areas**—Maj. Victor W. Hammond, Assistant Director of NASA tracking and information, detailed this program for the House Space Committee recently. He divided the NASA tracking and data acquisition into four areas. One area is that equipment which supports the sounding rocket, or vertical probe program; the second area supports the earth satellite vehicle program; the third supports manned space flight; and the fourth supports flights into deep space. Separate equipment is needed for all four areas, and the equipment needed for one of the areas is inadequate to service the needs of one of the other.

The three areas in which NASA will concentrate in 1960 are satellite, manned space, and deep space.

• **Satellite tracking**—By next October, according to Maj. Hammond, NASA will have 14 stations able to track and receive telemetering signals not only on the currently used frequency (108 MC), but on the new frequency recently assigned at the International Telegraphic Union's conference at Geneva (136 MC).

A great deal of money, according to Maj. Hammond, will go to changing existing Minitrack stations so that they can use the new 136 MC frequency. This will involve new antennas as well as new electronics.

Presently, the NASA Minitrack fence is capable of tracking satellites in low inclination equatorial orbits. But NASA in 1960 will add to its north-south Minitrack fence and east-west fence capable of tracking satellites in polar orbits. These new stations will be constructed in Alaska, Minnesota, Newfoundland and England. The two fences, in combination, will be able to track any satellite in any orbit.

Another item in the budget which will make the satellite tracking fence more effective are the funds for automatic translation equipment to transmit the information from the Minitrack fence into Central Control at the Goddard Space Flight Center. Presently, data must be translated into a suitable form so that it can be teletyped.

Another new fence must be constructed for the Project *Mercury* man-in-space program. This fence, which is being constructed by a team headed by Western Electric, must have the necessary electronic equipment to handle data in as near real time as possible, be able to pin-point the position of the vehicle at all times, complete orbital elements and transmit them to the next tracking station immediately, be able to transmit information from all of the stations to Goddard almost instantaneously, must be able to receive and transmit data on the astronauts' life-support equipment in real time so that trained observers can analyze it, and must be able to continuously revise and relay to recovery forces the capsule's impact locations.

To overcome these problems, NASA must have the latest in electronic equipment for the 18 stations in the world-wide *Mercury* network, and many millions of dollars will be spent in purchasing this equipment.

Adequate facilities for deep space tracking require that two more radio antennas similar to the 85 ft. parabolic radio telescope at Goldstone, Calif., be built at one-third intervals around the world. NASA presently expects to build the other two stations at Woomera, Australia, and at Esslen Park, South Africa. Contracts on these two stations have not been let.

The basic trucking capabilities of these large diameter stations extends from 300 miles to the edge of the solar system. Such powerful systems are needed because the deep space satellite vehicle will be transmitting on very low power. An example of the effectiveness of the Goldstone unit is that *Pioneer IV* was tracked to a distance in excess of 400,000 miles. The three stations must be spaced at equal distances around the globe so that the deep space vehicle can be tracked at all times.

Missile Attitude Recorded By Photoelectric Device

London—The Armament Research and Development Establishment of Great Britain has developed a photoelectric instrument which automatically measures and records the angular position in space of a guided missile.

It consists essentially of a telescope in which the image is swept at constant speed across an infrared detector by means of a rotating mirror. The sensitive area of the detector is in the form of a long narrow slit, so that at any given instant it detects only the energy falling within this narrow width, and as the image is swept across the slit the radiant energy from the missile is detected as a signal spike at some definite point along the sweep.

This gives the position of the missile in any one co-ordinate with respect to any convenient reference point; a second system, with its sweep at right angles to the first, gives the other co-ordinate. Recording is by a cathode ray oscilloscope with a constant-speed sweep initiated from the rotating mirror.

System accuracy is high because the slit width can be reduced to a value comparable with the resolution of the telescope.

CFTH Leads French Guidance Effort

Compagnie Francaise Thomson-Houston is a top producer of missile electronics

by Mario Sollima*

BAGNEUX, FRANCE—Significant advances have been made in Europe over the past year by uniting industry in various NATO countries for the common defense effort.

Under an agreement with the United States, Raytheon has licensed five NATO countries to build *Hawk* ground-to-air missiles. These will be used to supply missile batteries which will be established as part of NATO's defenses. A prominent electronic manufacturer has been selected in Germany, Italy, Belgium, Holland, and France by the governments of each country to produce the *Hawks*.

To coordinate the industrial aspects of the program, the five manufacturers have formed a single company, called SETEL, "La Societé Européene de Téléguidage."

• **CFTH**—Typical of these national industrial leaders is the Compagnie Française Thomson-Houston (CFTH), a leading French radio manufacturer.

For a number of years, it has devoted a large part of its electronics activity to the missile field. This includes equipment carried by the missile as well as ground guidance equipment.

The domain of this electronics effort is very broad and covers equipments of varying size, weight, complexity, and nature. Some have been put into quantity production after a long and successful development period. Others, still being designed, will be developed in preparation for future needs.

Even though all this equipment is brought under the single heading of missile electronics, it has but one thing in common and that is the goal: to guide a missile toward a target. Actually the equipment belongs in several distinct technical areas, which are often the extension of former equipment and studies. Thus ground or airborne guidance radar is the result of former development on surveillance or tracking radar. Similarly, the missile's electronic equipment evolves from radar circuitry as well as from miniaturization techniques used in communications.

• **New difficulties**—While ground or airborne equipment did not create any new problems, the equipment carried by the missile does bring new difficulties concerning manufacturing methods.

Besides the great accelerations occurring during launching, missiles are subjected to vibrations whose amplitudes and spectra are truly exceptional. At the beginning, when studies were made in this new field, the effect of vibrations had been underestimated and every manufacturer met with resultant mishaps. Since then, our laboratories have had to be given new test facilities to reproduce these vibrations, to learn their effects, and to avoid their disadvantages.

On the other hand, missiles have to be stored for long periods, during which time maintenance is difficult or impossible. After storage and during a few minutes of flight, the equipment must operate perfectly and with the greatest accuracy, lest the missile be lost and the shot be a total failure.

• **Operational testing**—Experience proves unfortunately that it is impossible in a laboratory to reproduce the actual missile flight conditions. It is necessary to complete missile development and check-out during launchings, which brings into play long preparation periods, great measurement difficulties and high costs. In case of failure, the analysis of causes is often quite delicate. In many instances, it is due to defective components, the quality of which is an essential factor in missile applications.

In short, missile electronics requires both a perfect knowledge of different branches of electronics and long experience in the field of missiles. The former was a part of our inventory; the latter is being acquired steadily.

• **Transition**—After having been very active in the field of large radio broadcasting transmitters, CFTH started to develop radar in 1945. It supplied and installed GCA landing radar for the main European airports. Then, after having produced numerous radar types including navigation radar for the French Navy, in 1952 it was awarded the biggest off-shore electronics contract given in Europe by the U.S. Government. This covered quantity production of an automatic tracking radar, type COTAL, that controls the firing of 90mm antiaircraft guns.

After that, numerous types of radar were developed and manufactured, including early warning radar and high-accuracy tracking radar for missile guidance, as well as measuring and computing equipment such as responders, computers, plotting boards.

Simultaneously, a great amount of study and development work was centered on missile seekers. After a number of missile firings which gave excellent results, the first seeker type is now in quantity production. Subsequent types, further improved, are under development.

CFTH also manufactures semiconductors (diodes, transistors, rectifiers, etc.), radar tubes (magnetrons, klystrons, TR's and ATR's, thyratrons, etc.) and, in particular, very-high-power klystrons for advanced early warning radar.

As an active partner in SETEL, CFTH is called upon to put all its electronics experience to work in a common enterprise, rich in promise for the defense of the free world.

**Mario Sollima is an engineering graduate of École Superieure d'Electricité, Paris. He started with Compagnie Française Thomson-Houston in 1927 and has devoted the main part of his activity to electronics. He is Chief Engineer of the company and Technical Manager of its Electronics Division.*

Belts Defined

Van Allen Areas Are Now Well Explored

by Jay Holmes

Less than two years after James A. Van Allen announced the discovery of a belt of radiation surrounding the earth, its composition and source have been reasonably well established.

Reports on rocket and satellite experiments in the last year have established that the two major belts of trapped particles consist primarily of "soft"—low energy-electrons. The outer

belt is made up almost wholly of electrons. Most of the inner belt is soft electrons; however, a small but important fraction consists of high-energy protons, a major hazard to manned space flight. Except in very long-term exposure, the soft electrons constitute a negligible hazard.

Dr. Homer E. Newell, Jr., of the National Aeronautics and Space Administration has said that a person flying through the belts would be exposed to between 2 and 50 roentgens of radiation—a total well below the lethal dosage for human beings. This could be reduced, of course, by shielding. For comparison, the National Committee on Radiation Protection has set the maximum allowance for industrial workers at 5 roentgens a year. A dose of 400 to 600 roentgens is usually lethal for about half of the persons exposed to it.

The inner zone appears to begin at 600 miles altitude and extends to something over 4000 miles, with a maximum intensity about 2500 miles over the magnetic equator. The zone extends about 30° north and south of the magnetic equator, leaving wide areas open about the magnetic poles.

The inner belt is much the more stable of the two. Most scientists now believe the high-energy protons contained in it are caused by cosmic rays—extremely high-energy nuclei that originate outside the solar system. These high-energy nuclei collide with nuclei in the outer atmosphere. Among the products are high-energy neutrons, which decay in turn into protons and electrons. The protons are trapped by the earth's magnetic field in the inner belt.

• **Solar origins**—The soft electrons in the inner belt are believed to originate in the sun. The same is true of the soft electrons in the outer belt. A major item of evidence in favor of their solar origin is that they vary in intensity with solar activity.

During the great magnetic storm of Sept. 4-5, 1958, the particles in the outer belt and the artificial Project *Argus* shell decreased sharply, *Explorer IV* measurements showed. But in the same period there was no change in the number of particles it counted in the inner belt.

The outer belt of electrons now is believed to be the immediate cause of the earth's aurora. In the regions of the magnetic poles, this belt dips down to minimum altitudes of less than 200 miles. At the equator, the outer zone begins at about 8000 miles, reaches a peak around 10,000 miles and subsides gradually for another 15,000 miles.

Primary cosmic-ray particles are a negligible hazard because they are ex-

remely rare. Their products are dangerous only because the earth's magnetic field concentrates them in a narrow zone.

Solar activity creates a variable hazard. During a solar flare, a space craft will be subjected to a fairly high intensity of energetic protons. During periods of solar quiet, the danger is negligible. Since it is impossible to predict solar flares, some scientists believe it may be necessary to suspend all manned space flight for a year or two at periods of maximum activity in the 11-year solar cycle.

• **Major findings**—Here is a thumbnail listing of some of the major radiation-belt experiments reported in the last year:

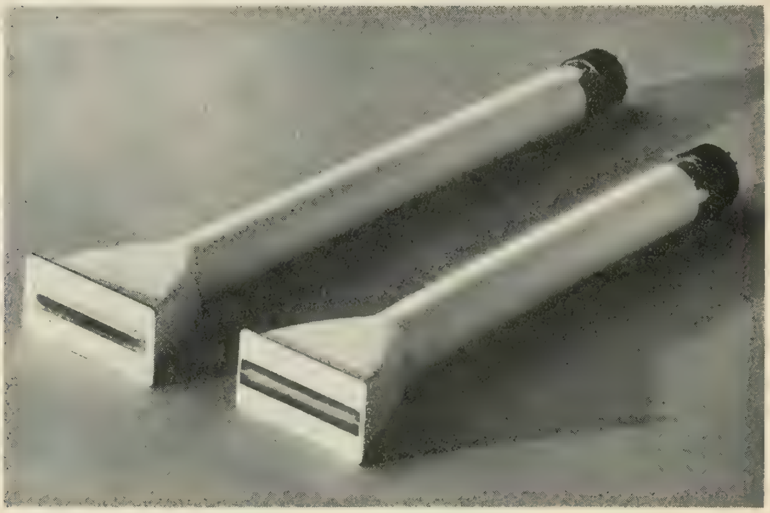
• Stanley C. Freden and R. Stephen White of the Lawrence Radiation Laboratory, Livermore, Calif., found protons with energies greater than 75 million electron volts in the inner zone at 750 miles altitude. The experiment, using a *Thor-Able* rocket at Cape Canaveral in April, 1959, was reported to the sponsor, the Atomic Energy Commission.

• Peter Mayer, University of Chicago, found that intensity of cosmic radiation doubled 40 minutes after a solar flare occurred on Sept. 3, 1959. Also, Mayer uncovered a small but well-resolved radiation belt between the two major zones. His results, from *Explorer VI,* were reported at the Cleveland meeting of the American Physical Society in November.

• V. I. Krassovsky and associates in the Soviet Union found very soft electrons at altitudes from 300 to 1175 miles with a maximum at 800 miles over the geomagnetic equator. Their data, from *Sputnik III,* launched May 15, 1958, was reported to the 10th International Astronautical Congress at London in September.

• C. E. McIlwain and Pamela Rothwell of the State University of Iowa found a marked decrease in the intensity of trapped particles in the outer zone during the Sept. 4-5, 1958, magnetic storm, while the number of particles counted in the inner belt showed no change. Their results, obtained from *Explorer IV,* were reported at the Cleveland meeting of the American Physical Society.

• John B. Cladis of the Lockheed Missiles and Space Division established that the outer belt consists primarily of low-energy electrons—with less than 0.1% protons. A four-stage *Javelin* rocket was used in the experiments at Wallops Island, Va., last summer, performed in cooperation with the Air Force Special Weapons Center. Cladis reported the results last month at the New York meeting of the American Physical Society.



Tube Facilitates Direct Printing

A cathode ray type tube has been developed for direct electronic printing at high speed on non-sensitized dielectric material by the Electron Tube Division of Litton Industries.

The component is already being incorporated in facsimile, oscillography, address-labeling and television-type image reproduction equipment. Other applications soon will include high-speed computer readout, controlled information storage and erase for military tactical display maps and stock control uses, projection transparency generation, multiple copy reproduction, and simultaneous recording at any number of dispersed stations.

Tubes employing these techniques, but using much closer spacing of the writing elements to accurately print minute detail, can be furnished for specific application. Element densities up to one million per square inch are feasible.

Operating circuitry and components of the new Litton Printapix tubes are similar to those normally used for display, readout or oscillographic applications. Ordinary television components and techniques are often quite satisfactory. For operating convenience, the tube is frequently run with the printing head at ground potential.

Used with the new Printapix direct writing tube, ordinary paper provides a low-cost base material for image rendition. Printing quality can be improved by making the opposite side of the paper slightly conductive. Transparent media such as glass and thin

transparent plastic or commercial sheet polyesters may be used with Printapix. Dielectric Material transport requirements depend on the proposed application.

Image development with the Litton Printapix direct writing tube is simple, inexpensive, instantaneous and dry. One system uses a developing powder with two components, a toner and a carrier. Agitation of the combination produces a tribo-electric charging. The toner is a finely pigmented plastic material which becomes positively charged and is thus attracted to the negative charge image on the dielectric material. A typical carrier material is powdered iron.

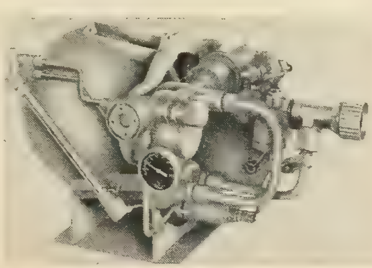
The developing powder is released as a cloud or fog very near the charged dielectric surface. Pigmented plastic is attracted to and retained on the charged areas by the coulomb force. The resultant image can either be erased for reuse of the base material and powder, or permanently fixed by a rapid heat cycle, pressure or other means. Since the pigment determines the resultant image color, multicolor reproductions may be obtained by proper development.

Circle No. 225 on Subscriber Service Card.

Packaged Cooling System

A cooling system for electronic gear recently announced by Vickers Inc., Division of Sperry Rand Corporation, utilizes fluorinated hydro-carbon fluids which act as thoroughly stable dielectric and heat transfer agents. The new package system dissipates an input of 47 KW with a unit weight of only 2 pounds per dissipated KW. System dry weight is 74 pounds.

This "Active" system—as compared



to "Passive," ablative-type cooling techniques—employs a centrifugal pump that circulates fluid through a liquid-to-air heat-exchanger core, then through the electronic gear. The fluid moves at rates as high as 52 gpm to maintain turbulent flow for maximum heat-transfer effectiveness. Output pressure of approximately 100 psi overcomes inherent resistances to flow found in coolant passages of electronic

gear, and holds the fluid in a liquid state for maximum dielectric strength.

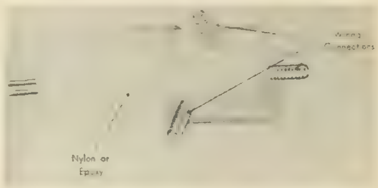
Individual component design considerations—increased output of the centrifugal pump, special pump bearings, fluid storage and fluid level indicator—compensate for hydrocarbon fluid characteristics such as high density, low lubricity and high coefficient of expansion.

An integral supercharge pressure control provides an operating range of from −65°F to +210°F. It prevents high pump pressure output at low temperatures and pump cavitation due to fluid vaporization at high temperatures.

Circle No. 226 on Subscriber Service Card.

High Temp Mercury Relays

A miniaturized family of 30 amp @ 115 volt AC mercury relays for ultra "high" and normal temperature requirements has been introduced by the Sorrels-Johnson Corp. These hermetically-sealed relays have a new feature—3-way wiring connections, to enable



multiple mounting positions heretofore unavailable in mercury relays of this type.

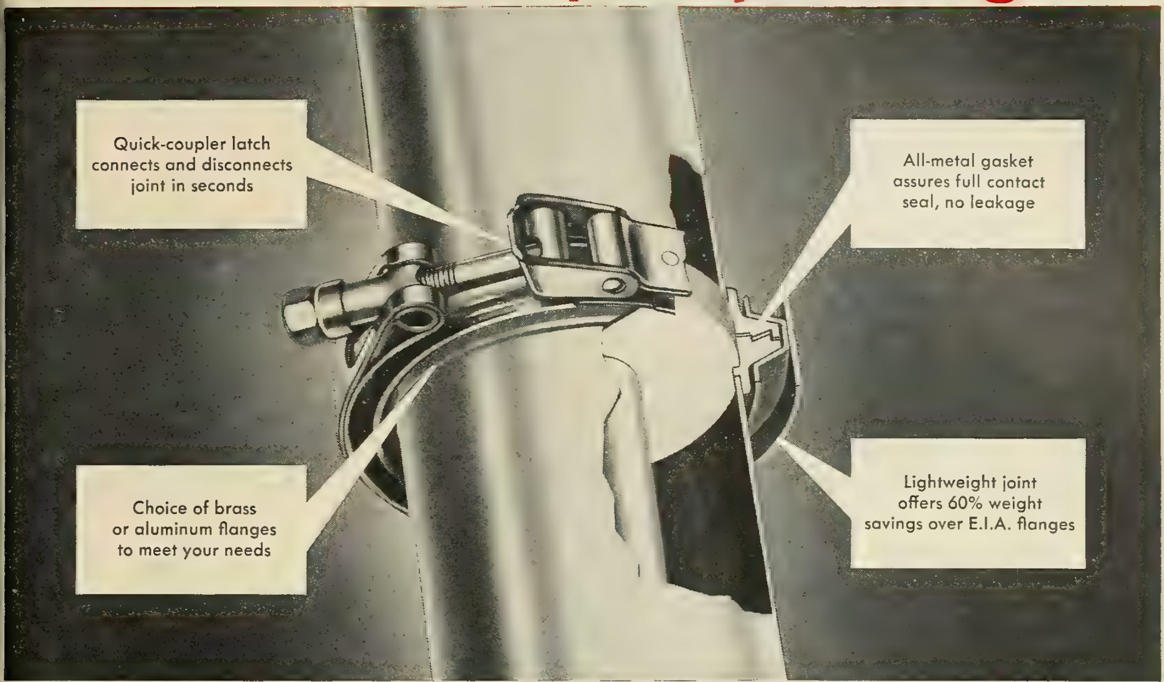
The relays give various time delays for AC relays without using thermal delay mechanisms. They enable remote control wiring with low voltage to the switch for homes; yet they handle strong current loads, despite their miniaturized size. Sealed construction, silent operation, and rugged materials make them ideal for a multitude of applications including street lights, instruments, grinders, and similar machine shop equipment.

Circle No. 227 on Subscriber Service Card.

Low-level Commutator

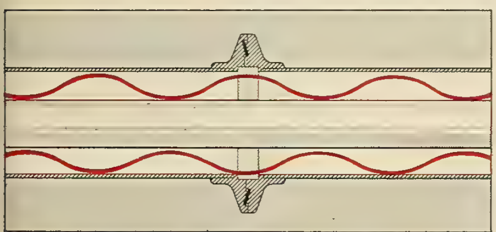
An ultrareliable low-level communtator has been produced by San Diego Scientific Corp. for switching millivolt signals at high speed. The model illustrated handles 96 channels of strain gauges and thermo-couples at 10,000 samples per second without pre-amplifiers. This magnetic multiplexer (Magne-Plexer) uses miniature magnetic amplifiers with a radio frequency

Zero Radio Frequency Leakage!



MARMAN All-Metal CONOSEAL Joint Seals Perfectly

INSTALLS QUICKLY ON ALL RIGID COAXIAL LINES



Cross section of coaxial line shows how flanges of CONOSEAL Joint hold metal gasket to provide 100% metal-to-metal line seal.

Marman's CONOSEAL Joint is designed to eliminate radio frequency leakage in coaxial lines. It features an all-metal gasket seal that seals lines subject to increased power. The CONOSEAL also provides a 60% weight savings over standard E.I.A. flanges and can be installed quickly, with minimum care and skill.

Available in standard styles and special couplings for electronic equipment, some versions of the CONOSEAL are designed to operate at temperatures from −300°F. to +2000°F. with pressures up to 20,000 psig. Marman CONOSEAL Joints are now used by Hazeltine Electronics Division.

For full details on Marman CONOSEAL Joints for electronic use, mail the coupon below.

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Please send full information on Marman CONOSEAL Joints for Coaxial Lines.

Name____________________

Title____________________

Company____________________

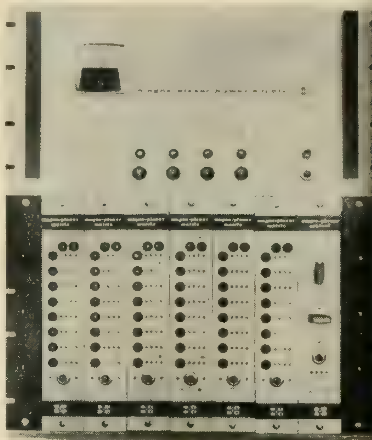
Address____________________

City__________ Zone_____ State_____

Circle No. 36 on Subscriber Service Card.

carrier, in combination with a nominal amount of transistor circuitry. Because of the floating inputs, it has practically infinite common mode rejection. Output is 5 volts of either sign. Typical accuracy is 0.2%.

The signal circuits are never interrupted for switching, which is accomplished by switching carrier power via

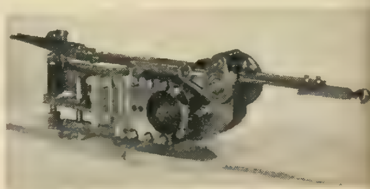


a solid-state matrix, thus eliminating contact potential errors in the signal input circuits. Programing can be varied by selecting desired circuits within the carrier switching matrix without disturbing, patching or reconnecting the signal inputs. Actual program selection is accomplished by replacing plug-in cards.

Circle No. 228 on Subscriber Service Card.

Pneumatic Servo Actuator

Development of a pneumatic servo actuator which has undergone severe endurance testing for 42 consecutive



hours at temperatures ranging up to 1600°F has been announced by the Controls and Accessories Division of The Marquardt Corporation.

The new air motor actuator is designed to function in extreme temperature and radiation environments. Fast response combined with advanced pneumatic servo valve and stabilization techniques make it possible to integrate the unit into aircraft, missile and nuclear control systems. Typical appli-

cations include rocket-engine thrust-vector controls, aerodynamic surface controls and reactor servicing machinery and control rod drives.

Prime mover of the actuator is an opposed pair of nutating disc motors with a rack and pinion drive. The absence of complex valving assures high reliability. Designed with a minimum amount of rubbing surfaces and constructed of high-temperature base alloys, the Marquardt actuator needs no lubrication.

Circle No. 229 on Subscriber Service Card.

Ten Per Cent Solar Cells

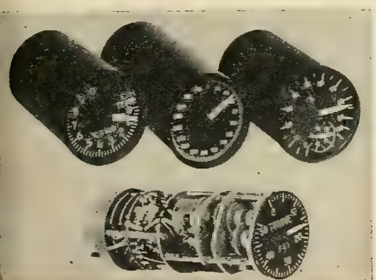
Hoffman Electronics Corp. has announced that it can offer guraranteed 10% minimum conversion-efficiency solar cells for the first time in production quantities.

Also available for the first time are shingled solar-cell assemblies with 10% minimum conversion efficiencies. The high-efficiency cells, which are type 120C, measure 1 by 2 centimeters (0.4 by 0.8 in.), have a spectral response ranging from 4000 to 11,500 angstroms and an operating temperature range of –65°C to 175°C.

Circle No. 230 on Subscriber Service Card.

Modular-Built Indicators

A modular construction approach toward subminiature servo indicators developed by Servo Development Corp.



utilizes standard stock parts and is suited for prototype and limited production applications where delivery and engineering costs are important.

The basic module is the gear box in which up to seven .0937-in. diameter shafts are mounted in ABEC-7 ball bearings. Gear ratio of up to 65,000/1 are obtainable using precision 2 stock gears. The component module utilizes standard plates for mounting size 8 or size 10 rotating component. The dial section, another module, also utilizes standard parts. Dial configurations, which are to customer's specifications, are photographically processed to an accuracy of 6 minutes of arc.

Circle No. 231 on Subscriber Service Card.

New Literature

PHOTOMICROGRAPHY. A new book on "Photomicrography of Metals," a reference guide for metallurgists, has been published by Eastman Kodak Company. The 46-page data book may also serve as a short course in photomicrography for those metallurgists interested in reviewing the latest techniques in this field. In addition, Kodak points out, the booklet should be a valuable addition to metal industry technical libraries and a supplemental text for college-level metallurgy students. It is available for 50¢ plus 10¢ handling.

Circle No. 200 on Subscriber Service Card.

CORRECTION. The new literature item in M/R's edition of Jan. 11, page 42, describing a booklet on true position dimensioning available from the Scintilla Division of the Bendix Aviation Corp., neglected to point out that cost of the booklet is $3.00 ($2.50 in lots of 10 or more).

GENERATING COMPONENTS. Engineering specifications and application descriptions of electrical components for missile ground power equipment is contained in General Electric Company's new bulletin GEA-6973. The 12-page bulletin covers electrical generating components at either 60 or 400 cycles for applications such as military aircraft ground power, commercial aircraft ground power, computer power supply, missile ground power and special military projects. Application data, outstanding features and technical descriptions, as well as engineering performance statistics, cover such electrical equipment as high speed aircraft-type alternators, regulators and exciters; semi-industrial alternators, regulators and exciters; ac-to-ac and ac-to-dc motor-generator sets and static speed and voltage-regulated motor-alternator sets.

Circle No. 201 on Subscriber Service Card.

GAMMA SPECTROMETER SYSTEM. Data folder GSS-1 giving details on a new gamma spectrometer system designed to eliminate the "dark current" defect common to conventional systems is available from Nuclear Measurements Corp. Known as Model GSS-1, the system is said to offer better resolution over a wider range, and to provide greater precision in gamma spectroscopy than possible with any other equipment now available.

Circle No. 202 on Subscriber Service Card.

contracts

NASA

Tracerlab, Waltham, Mass., for research and development on a radiological analyzer for nonradioactive gases. Amount not disclosed.

$33,500,000—McDonnell Aircraft Corp., St. Louis, for *Mercury* space capsules.

$62,717—Mobile Aerial Towers, Inc., Fort Wayne, Ind. for services and materials for pilot's capsule tower for delivery to Cape Canaveral.

NAVY

United States Chemical Milling Corp., Los Angeles, for supplying fiberglass linings for the *Sidewinder*. Amount not disclosed.

$25,200,000—Convair Div., General Dynamics, for advanced *Terrier* missiles.

MISCELLANEOUS

$9,500,000—Electronic Communications, Inc., St. Petersburg, Fla., for ALRI electronic equipment. Subcontract from Burroughs Corp.

$371,000—American Electronics, Inc., American Concertone Div., Culver City, Calif., for special-purpose tape recorders. Subcontracts from Sperry Gyroscope, Western Electric and Temco Aircraft.

$180,000—Trans Electronics, Inc., Canoga Park, for ground support equipment used with the *GAR 11* missile project. Subcontract from Hughes Aircraft Co.

$60,000—Electronic Engineering Co., Santa Ana, Calif., for design and construction of data translation equipment. Subcontract from Sandia Corp., Albuquerque, N.M.

ARMY

Southwestern Industrial Electronics Co., Division of Dresser Industries, Inc., Houston, for building 240 signal conditioning modules for use on the *Pershing*. Subcontract from Martin Co.

$10,888,000—Paul Hardemann, Inc., Stanton, Calif., for building and installing propellant loading sytsems for seven *Atlas* missile sites.

$4,499,634—Raytheon Co., Waltham, Mass., for *Hawk* missile test equipment.

$2,667,475—Douglas Aircraft Co., for *Nike-Hercules* launching area items.

$1,312,341—Chrysler Corp., Detroit, for additional *Jupiter* missile components.

$1,111,860—Federal Pacific Electric Co., Newark, N.J., for furnishing 5 kv metal-clad switchgear assemblies for six *Titan* missile launching items.

$1,075,000—Hughes Aircraft Co., Fullerton, Calif., for repair parts for the missile monitor system.

$975,000—Sperry Rand Corp., Salt Lake City, for research and development of *Sergeant* missile system.

$481,500—Aerojet-General Corp., Azusa, Calif., for classified work.

$399,324—Hayes Aircraft Co., Birmingham, Ala., for ground support equipment for the *Saturn*.

AIR FORCE

United Aircraft Corp.'s Norden Division, Stamford, Conn., for analog-to-digital converts to be used with the *Hound Dog* missile. Subcontract from North American Aviation Inc.'s Autonetics Div. Amount not disclosed.

$7,980,000—Burroughs Corp., Detroit, for training programs for installation personnel, installation of hardware and on-site logistic support and maintenance supply depot support in connection with the SAGE program.

$9,000,000—Callery Chemical Co., Muskogee, Okla., for production of pentaborane.

$116,000—Space Electronic Corp., Glendale, Calif., for studies and experiments in subsurface propagation of electromagnetic waves.

$100,000—Burton Manufacturing Co.'s Instrument Div., Santa Monica, Calif., for accelerometers. Two contracts.

$96,000—Space Electronics Corp., Glendale, Calif., for study of a terminal guidance system for the *Titan*. Subcontract from Avco Corp.'s Research & Advanced Development Division.

$64,848—General Electric Co., Scranton, Pa., for electron tubes.

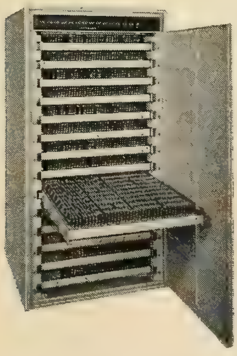
$51,600—Geophysical Institute, University of Alaska, for investigation of solar-induced phenomena at magnetically conjugate points on the earth.

$51,321—G. T. Schjeldahl Co., Northfield, Minn., for modification of design of the Robin meteorological rocket balloon and fabrication of balloons.

$42,678—General Precision Lab., Inc., Pleasantville, N.Y., for wind computers to be integrated into a complete airborne system.

Comparison between advanced Navy computer (foreground) and Univac Scientific (background) portrays dramatic reduction in size of large-capacity data processing equipment achieved by Remington Rand Univac.

The case of the shrinking computer



Central computer of the advanced Navy system shown at top of page illustrates compact size and ease of maintenance provided by building block construction. Containing 4,100 packages, the cabinet occupies only 37 cubic feet of space. Roll-out drawers permit easy and rapid access to component packages.

Remington Rand Univac compresses large-capacity performance into small package

In an advanced computer developed for the U.S. Navy, Remington Rand Univac dramatically reduced the size of large-scale data processing equipment. With a 32,786-word memory, the capacity of this miniaturized computer almost equals that of earlier vacuum tube systems of 10 times its size.

This compact, completely transistorized system has a cycle time of eight micro-seconds, and is linked with seven input-output registers, each of which may operate simultaneously and independently of computer programs.

Remington Rand Univac has openings on projects associated with advanced equipment such as the computer described above. These positions offer you the opportunity to advance your career development while at the same time participating in rapid advances in the state of the art.

If you are thinking of changing positions, or would consider a change, be sure to investigate the openings described below.

Opportunities for Electronic Engineers, Physicists and Mathematicians:

DEVELOPMENT ENGINEERS—To develop advanced techniques in high speed memory circuits, switching circuits, and other data processing requirements. Engineers are also required for work on communications systems, antenna couplers, and servo mechanisms.

SYSTEMS ENGINEERS—Engineering, Mathematics, or Physics degree with experience in weapons and missile guidance systems involving digital control, digital conversion, radar and communications information processing, and display and output equipment.

PHYSICISTS—B.S., M.S., and Ph.D. levels for research and development of systems and circuitry of digital computers for evaluation of component reliability, and for physical research including evaporative thin film research and ferro-magnetic domain behavior as applied to computer elements.

PRODUCTION ENGINEERS—To plan automated processes, methods, and tooling for the world's most reliable computers. These openings on large production programs require imagination and creativity. Engineering degree preferred, with experience on electronic equipment.

RELIABILITY ENGINEERS—To perform reliability analysis and predictions, develop failure reporting procedures, analyze failures, and recommend corrective action.

Inquiries will be given prompt and confidential consideration. Send a resume of education and experience to:

R. K. PATTERSON
Dept. B-2

Remington Rand Univac

Division of Sperry Rand Corporation
2750 West Seventh Street, St. Paul 16, Minnesota.

There are also immediate openings in all areas of digital computer development. Inquiries should be addressed to:

F. E. NAGLE—Department B-2,
REMINGTON RAND UNIVAC
Division of Sperry Rand Corporation
1900 West Allegheny,
Philadelphia 29, Pennsylvania.

R. F. MARTIN—Department B-2,
REMINGTON RAND UNIVAC
Division of Sperry Rand Corporation
Wilson Avenue,
South Norwalk, Connecticut.

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Dr. Helmuth W. Schultze: Appointed director of commercial sales and development for The Alloyd Corp. Was formerly manager of new chemical and catalyst development for Climax Molybdenum Co., a division of American Metal Climax, and performed similar duties for Union Carbide Metals Co.

SCHULTZE

Jack Larsen: Elected manager of General Devices, Inc.'s Special Projects Department. Previously served as consultant to the Atomic Energy Commission in the development of reactor controls for the Nautilus and Sea Wolf and headed the Navy Dept.'s missile guidance section on the *Polaris*.

Jack H. Frailey: Former manager of missile systems, Missile Electronics and Control Div. of RCA, appointed to the newly-created post of executive assistant to the general manager at Itek Corp.'s Information Technology Center. Was previously project director of Lockheed Aircraft Corp.'s X-7A Ramjet test vehicle and *Polaris* missile program.

Harold F. Lanier: Manager of Goodyear Aircraft Corp.'s Guidance Engineering Dept., named special assistant to **James Bridges,** director of electronics in the Office of the Director of Defense Research and Engineering, Department of Defense. Lanier headed the group which developed ATRAN, a self-contained electronic guidance system used in the Air Force's *TM-76A Mace* missile.

LANIER

Donald T. Atkinson: Former operations research manager replaces **G. P. Bieging** as manager of marketing for General Electric Co.'s Missile and Space Vehicle Dept. Prior to joining the company in 1959 was vice president of operations for Edgcomb Steel of New England, Inc.

Dr. Robert W. Bass: Appointed chief scientist at Aeronca Manufacturing Corp.'s Aerospace Division, reporting to **Dr. P. A. Castruccio,** technical director. He will direct research in celestial mechanics and space-vehicle orbit-trajectory theory. Previously held research positions at Johns Hopkins and Princeton universities.

Karl R. Wendt: Formerly chief engineer of communications and radar section at Martin-Denver, chosen manager of Colorado Research Corp.'s research department.

Edwin S. Coyle: Promoted to manufacturing manager of the Electronic Controls Section of The Budd Co. Was formerly a project engineer in general research and development.

George F. East: Senior project engineer promoted to chief engineer in the Dynamics Division of Clary Corp.

T. F. Dixon: Director of research and engineering for Rocketdyne, division of

North American Aviation, Inc., chosen chairman of an ad hoc group charged with recommending a program of research and development of advanced rocket propulsion systems to the Department of Defense.

David William Moore: Formerly manager of Lear Inc.'s Applied Research Laboratory, elected manager of the Solid State Physics Laboratory. Previous posts: Director of research facilities, Servomechanisms, Inc. and division manager and project engineer, Fairchild Camera and Instrument Corp.


MOORE

Arthur Mac Arthur: Formerly with Lyndon Aircraft Inc., named manager-engineering, Military and Industrial Products Div. of Breeze Corporations, Inc. Has previously served in various management and engineering capacities with Convair, Avion, Inc., and Piasecki Helicopter.

Henry C. Guhl: Elected vice president-engineering by the board of directors of the National Vulcanized Fibre Co.

Frank J. Hierholzer, Jr.: Named assistant department head of the Microtronics Dept. of Sperry Semiconductor division of Sperry Rand Corp. Was formerly senior engineer in the solid state electronics engineering section of the Materials Engineering Dept. of Westinghouse Electric Corp. Has several patents in the fields of arc discharge devices and semiconductor applications.


HIERHOLZER, JR.

Edward Watt: Former design engineer with the Hamilton Watch Co., Electronics Div., joins Nacimco Products, manufacturer of electronic and electro-mechanical instruments and systems, as senior electronics engineer.

Edward L. Rucks: Former manager of Aerojet-General Corp.'s Plastics Division, named director of the firm's newly formed Structural Materials Division, the result of combining the Structural Plastics Div. and the Materials Dept. **Lawrence L. Gilbert,** former chief of the Materials Dept., will assist Rucks.

Neil J. Waterman: Appointed assistant head of the *Atlas* project office of flight test operations, Space Technology Laboratories, Inc. He joined STL project office in August, 1959, as an administrative engineer.

reviews

Here are abstracts of some papers given at the ARS Solid Propellant Rocket Research Conference. For further information, contact American Rocket Society, 500 5th Ave., New York 36, N.Y.

The Performance of Plug-Type Rocket Exhaust Nozzles. K. Berman and F. W. Crimp. General Electric Co. ARS paper 1047-60.

The paper reviews some of the essentials of plug nozzle design and operation and presents data on the application of plug nozzles to rocket propulsion systems.

Conclusions reached are: the performances of plug-type rocket exhaust nozzles exceeds that of a conventional converging-diverging nozzle in the over-expanded condition; the use of plug-type configuration on large liquid-propellant engines appears to offer distinct advantages in size, weight, cost, and performance; plug nozzle technology has advanced to the point that the plug is becoming competitive with clustered conventional nozzles for some solid-rocket applications; the plug-type nozzle configuration is adaptable for use as a variable throat area device.

A Method of Strength Analysis of Solid Propellant Rocket Grains. N. N. Au, Hughes Aircraft Company, Culver City, California. ARS paper 1062-60.

Steady-state stress and strain distributions in long cylindrical case-bonded propellant grains are developed on the basis that the propellant is an elastic, homogeneous, and isotropic material in generalized plane strain. Thermal effects are studied for case-bonded grains exposed to a temperature environment that is different from the cure temperature for a sufficiently long time, such that thermal equilibrium is achieved.

Stress and Strain Analysis of Cylindrical Case-Bonded Grains. J. Vandenkerckhove, Free University of Brussels and G. Lampens, Joint Powder Factories of Belgium. ARS paper 1064-60.

The paper analyzes the stresses and strains which appear in a case-bonded solid-propellant grain during the combustion, under the influence of the gas pressure.

Several conclusions important to the grain designer include: for thin, high performance walls, the chamber elasticity must be taken into account; the mechanical resistance of the grain is much more critical for large web fractions than for small ones; the temperature and rate of strain dependence of the modulus of elasticity and of the Poisson's ratio must be known accurately.

An Experimental Investigation of Unstable Combustion in Solid Propellant Rocket Motors. Capt. W. Grant Brownlee, Royal Canadian Artillery, and Frank E. Marble, Jet Propulsion Laboratory.

Experiments with case-bonded, cylindrically perforated motors using a polysulfide, ammonium-perchlorate propellants were reproducible as a result of careful manufacturing control and extended propellant curing time. In these motors, the oscillations were in the fundamental pseudo-standing tangential mode and were accompanied by increases in the average burning rate. At sufficiently high pressure levels all firings were stable. Reduction of the operating level led to mild instability. A sufficient further reduction produced a

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important openings for senior E.E.'s and Physicists to assume responsibility for development of

new infrared search systems

Progress of the Hughes Infrared and Guidance Department reflects Hughes overall growth. In the past ten years, employment has risen from under 2,000 to over 34,000 in the several semi-autonomous divisions of Systems Development, Research, Commercial Products, Ground Systems, Communications and Manufacturing. The infrared activity includes these typical projects:

These activities have created a number of new openings for graduate engineers and physicists with analytical and inventive abilities.
You are invited to investigate these openings if you have several years of applicable experience in infrared optics or electronics, and can assume responsibility for systems analysis and preliminary design.
The importance of infrared development at Hughes is shown in substantial development contracts and in the fact that Hughes is investing its own funds in further exploration.

1. **Air-To-Air Missiles**
2. **AICBM**
3. **Air-To-Air Detection Search Sets**
4. **Satellite Detection & Identification**
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Infrared Search-Systems Range Performance: R. H. Genoud /Missiles Seekers and Homers: W. A. Craven, et al.
Servomechanisms Design Considerations for Infrared Tracking Systems: J. E. Jacobs /Simulation of Infrared Systems: H. P. Meissinger

sudden change to maximum instability. Continued reduction in pressure level from this point resulted in a gradual decrease in the degree of instability.

Reliability Aspects of Solid Propellant Rocket Engines. B. R. Adelman and A. C. Keathley, United Research Corp., Menlo Park, Calif. ARS paper 1043-60.

The performance of the large solid-propellant engines presently under development will compare favorably to that of liquid-propellant systems such as LOX-kerosene and the common storable propellants.

Further, the potential exists for increases in the specific impulse of solid propellants using formulations now under study on laboratory scale which will permit overall performance characteristics such that solid-propellant engines will be competitive with practically any liquid units.

Resonant Burning of Solid Propellants: Review of Causes, Cures and Effects. R. H. Wall, Thiokol Chemical Corp., Redstone Division, Huntsville, Ala.

Unstable operation of solid-propellant rocket engines refers to unpredictable chamber pressure irregularities that cannot be explained by the common equilibrium pressure equation. In the more severe instances of unstable operation the engine chamber can be ruptured; lesser degrees of the problem might seriously affect performance.

This article presents a review and a discussion of the many factors associated with the occurence and suppression of the phenomenon.

An Experimental Comparison of Contoured and Conical Nozzles, Robert E. Overall, Thiokol Chemical Corp., Huntsville, Ala.

A comparison is made between the performance of conical and contoured nozzles in static tests. Data were gathered for approximately 250 solid-propellant motors loaded with propellant containing a very high percentage of metal additives. The contour designs tested were arbitrary bell-shaped nozzles, "Foelsch" contours, and contours based on a two-dimensional method of characteristics.

Propellant Ignition by High Convective Heat Fluxes, A. D. Baer, N. W. Ryan and D. L. Salt, University of Utah, Salt Lake City.

The ignition of composite rocket propellants by convective heat fluxes in the range of 40 to 400 BTU per sq. ft.-sec. is reported. The technique employs a shock tube as a hot gas generator, the shocked gas being used as the heat source. Ignition times in the range 5 to 45 milli-seconds were obtained, and a pronounced effect of oxygen in the heating gas was observed.

CLASSIFIED

Now America's Army has a NEW capability. It can move men and equipment swiftly . . . in and out of restricted areas . . . for dispersion or rapid grouping . . . day or night . . . and with PINPOINT PRECISION.

This new capability — swift mobility with unerring accuracy — was made possible with Ryan's new navigation systems: the Army's first successful self-contained navigation sets, both for fixed and rotary wing aircraft.

This advanced automatic navigator was designed and developed by Ryan Electronics under Army contract and tested by the Army Electronics Proving Ground at Ft. Huachuca. Ryan's AN/APN-129(V) navigator is in production for use with the Army AO-1F Mohawk and RL-23D surveillance aircraft, and the Model 120B is guiding H-19 and H-34 Helicopters.

Ryan navigators are light, compact, and trouble-free. With no minimum altitude limitation, they are ideally fitted for the Army's low-level "nap of the earth" operations and vertical envelopment combat missions. Independent of ground facilities, they are practically immune to countermeasures.

The new navigators are outstanding examples of Ryan Electronics knowledge — indicative of Ryan's capabilities in space navigation, doppler inertial guidance, and other advanced electronics fields.

Ryan's rapid growth in electronics is creating new opportunities for engineers

RYAN ELECTRONICS

DIVISION OF RYAN AERONAUTICAL COMPANY • SAN DIEGO, CALIFORNIA

RYAN BUILDS BETTER

MARCH

Navy League Seapower Symposium, Sheraton Park Hotel, Washington, D.C., March 1-3.

Royal Astronomical Society and Royal Meteorological Society, "The British Rocket Programme," Royal Society of Arts, London, March 4.

British Interplanetary Society, "The Exploration of the Moon," Caxton Hall, London, March 5.

American Society of Mechanical Engineers, Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, March 6-9.

Society of Instrument Technology, "Data Reduction for Guided Weapon Trials at Aberporth," Manson House, London, March 7.

Heat Transfer Symposium, Mechanical Engineering Dept., University of Florida, Gainesville, March 7-8.

Society for Aircraft Material and Process Engineers, Midwest Chapter Symposium, "Processing Materials for Re-Entry Structures," Miami Hotel, Dayton, Ohio, March 9-10.

Mechanical Properties of Engineering Ceramics, North Carolina State College School of Engineering and Office of Ordnance Research, U. S. Army, N.C. State College Campus, Raleigh, March 9-11.

National Flight Propulsion Meeting, Institute of the Aeronautical Sciences, (classified), Cleveland, March 10-11.

Electronic Industries Association, Defense Planning Seminar, Statler Hilton Hotel, Washington, D.C., March 15.

Institute of Radio Engineers 1960 International Convention, Waldorf-Astoria Hotel and New York Coliseum, New York City, March 21-24.

Symposium on Optical Spectrometric Measurement of High Temperatures, sponsored by University of Chicago's Applied Science Foundation; Jarrell-Ash Co.; National Science Foundation, University of Chicago, March 23-25.

22nd Annual American Power Conference, sponsored by Illinois Institute of Technology, American Society of Mechanical Engineers and others, Sherman Hotel, Chicago, March 29-31.

APRIL

University of Connecticut, Sixth Annual Advanced Statistical Quality Control Institute, Storrs, April 3-15.

Solar Energy Symposium, American Society of Mechanical Engineers, and Mechanical Engineering Dept., University of Florida, Gainesville, April 4-5.

1960 Nuclear Congress: "What Will the Future Development of Nuclear Energy Demand From Engineers?" sponsored by 28 engineering, scientific, management and technical organizations. Includes 6th Nuclear Engineering and Science Conference; 8th NICB Atomic Energy in Industry Conference; 6th International Atomic Exposition, New York City Coliseum, April 4-7.

American Chemical Society, 137th National Meeting, Cleveland, April 5-14.

American Rocket Society, Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif., April 6-8.

1960 National Meeting "Hyper-Environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, April 6-8.

Royal Aeronautical Society, Coventry Branch, "The Optimum Size of Rocket Engines," Coventry, England, April 7.

ASME-SAM Management Engineering Conference, Statler Hilton Hotel, New York City, April 7-8.

Advertiser's Index

editorial . . .

Russian Threat Lies in 'Space Gap'

Writing on this page over the past year and a half, we have had frequent occasion to criticize the nation's space program and the people responsible for it. We shall continue to do so until the program gets the national effort and funding it deserves. Most particularly shall we continue to voice strongly our feelings about a national leadership which not only refuses to enter the space race—but declines to admit there is one.

On the other hand, there have been few allusions here to the so-called "missile gap" and "deterrent gap"—for several reasons.

First, the importance of the "missile gap" is exaggerated. No country could perform the industrial, logistic and military miracle of wiping out or even critically wounding the deterrent force of the Western World in one secret, instantly coordinated blow.

Second, the "deterrent gap" is probably nonexistent. The combination of SAC bombers, RAF bombers, nuclear-armed NATO fighter-bombers, IRBM's on station in Europe and ICBM's going on station in the U.S. is the most destructive offensive force ever known—if even half of its power were to be unleashed. True, it must be maintained, but a "gap" would come only if we criminally permitted it—and this we will not do.

Third, the Russians are quite prepared to forego conquest by military invasion if they can find a better way to do it. At the moment they have two excellent routes for this which must make the aspect of an atomic holocaust seem to them both foolish and unnecessary.

The world-wide prestige they have won with their successes in the space race can give them vast economic and political gains without fighting for them. And if they gain control of space—if they are able to deny the rest of the world equal rights in space—then they automatically gain control of the earth anyway.

To return to the so-called "missile gap" and U.S. deterrent strength, we quote the words of Lt. Gen. Bernard Schriever, commander of the Air Force Research and Development Command and the one man most responsible for achieving America's long-range ballistic missile capability. Speaking at the recent Goddard Memorial dinner, he said:

"In less than 5½ years, a multibillion-dollar nationwide missile and space-vehicle industry has been created. Today over 100,000 people are working full-time to bring into the operational inventory our *Atlas, Titan, Thor* and *Minuteman* missiles. Tens of thousands of people also are working on the U.S. Navy's *Polaris* missile, together with its nuclear-powered submarine base, and on the *Jupiter* missile developed under the stewardship of the Army. Countless thousands of other American citizens are supporting this nucleus of full-time workers. Moreover, the missile industry rests on a solid foundation. More than a billion dollars worth of vast and complex test facilities, production plants and fully instrumented missile and space vehicle test ranges, extending thousands of miles across the Atlantic and Pacific oceans have been brought into being.

". . . Schedules laid down for the *Atlas* program in 1954 and for the *Thor* and *Jupiter* programs in 1955 have been exceeded. The Navy's *Polaris* missile program, which was the outgrowth of a joint Army-Navy effort on the *Jupiter* in 1955, is making excellent progress. The Air Force *Atlas* and *Thor* missiles and the Army-developed *Jupiter* missiles are in production. The *Polaris* is expected to become a part of the deterrent power of the U.S. later this year. The Air Force *Minuteman* missile is scheduled to be in the force in significant numbers around mid-1963." . . .

Either a missile or a deterrent gap could be dangerous, but we believe these possibilities are being effectively dealt with. It is the more subtle danger of the "space gap" which we sincerely believe is the greatest threat.

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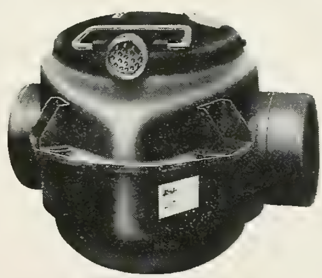

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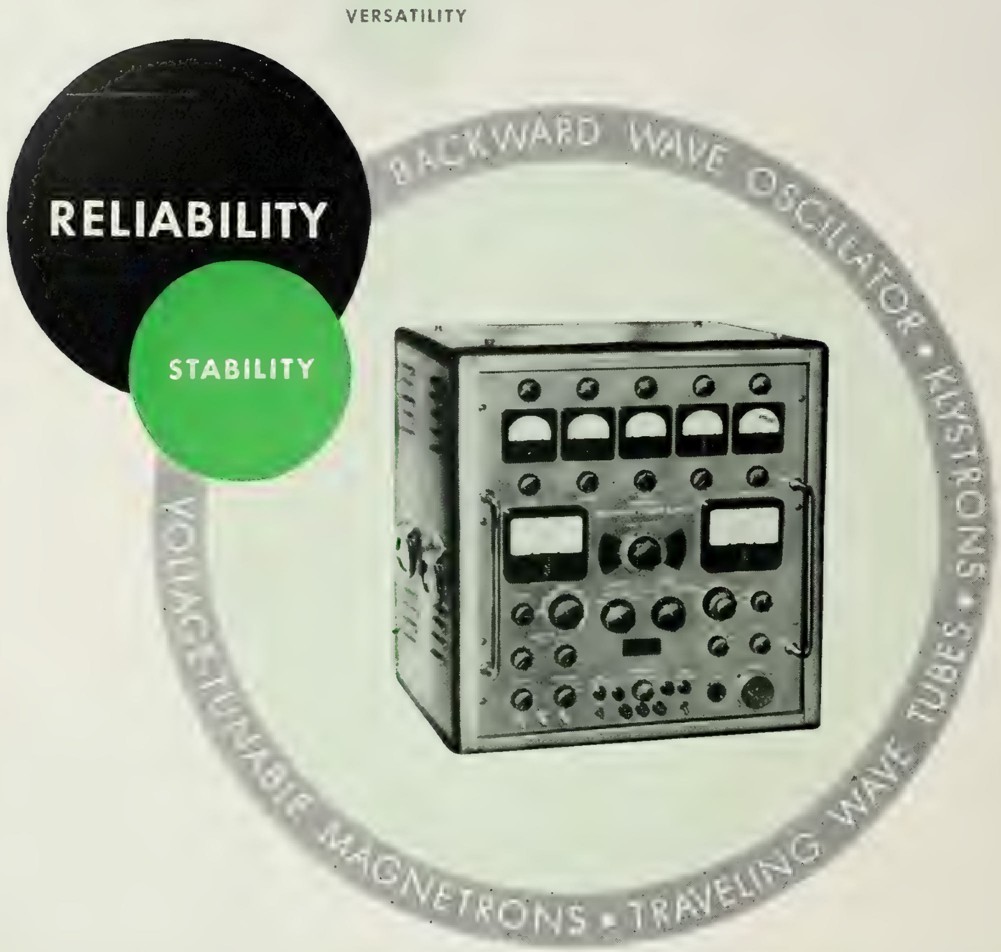

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MARCH 7, 1960

THREADING—NEW TWIST FOR SOLIDS

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

TEST EDITION OF M/R ASTROLOG

tus report on U.S. missiles, rockets d space vehicles—and all satellites . . 15

AN AMERICAN AVIATION PUBLICATION

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Missiles and Rockets Volume 6 Number 1

Published each Monday with the exception the last Monday in December by Americ Aviation Publications, Inc., 1001 Vermont A N.W., Washington 5, D.C. Wayne W. Parri *President;* Leonard A. Eiserer, *Executive V President & General Manager;* Fred S. Hunt *Vice President & Editorial Director;* A. Stackpole, Eric Bramley, Robert R. Parri *Vice Presidents.*

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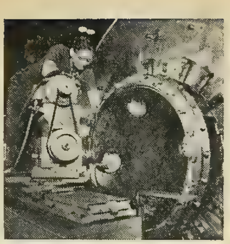
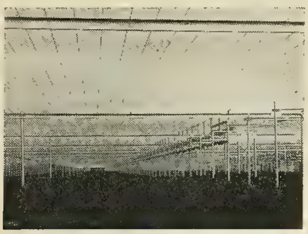
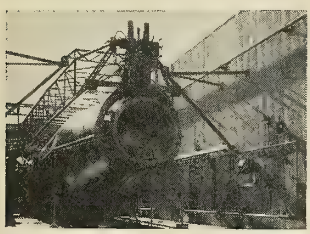


COVER: Merz Engineering's giant thread mill cuts buttress threads in large solid motor case aft closure. This development in technology generated a series of new machine designs. See report on p. 36.

M/R'S ASTROLOG goes into its fourth bimonthly edition with this issue. For the latest report in this unique series, incorporating recent changes, turn to p. 15.



ANTENNA array of Space Surveillance Receiver is 1600 ft. long, 300 ft. wide. An article on ARPA's "dark satellite" detection system—and the interservice rivalry over it—begins on p. 21.



ON SITE at Vandenberg AFB now are this and two other Convair *Atlas* ICBM's in "coffin" type launchers, bringing to six the total on launchers at the base. A report with first photographs starts on p. 34.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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NEW
TRAIL SENSE
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The horizon is always clear for the F-105 Thunderchief with NASARR . . . the compact, lightweight monopulse radar system designed and built by Autonetics. NASARR gives the Republic Thunderchief an uncanny sixth sense for air-to-air search, automatic tracking, air-to-ground ranging, ground mapping, and terrain avoidance—regardless of height, speed, attitude, or visibility. For more than a decade Autonetics has pioneered the way with monopulse radar systems like NASARR to give America's pilots the keenest trail sense possible.
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the
missile
week

Washington Countdown

IN THE PENTAGON

Dyna-Soar is delayed again . . .

by another technical study ordered by the Administration. The study is holding up new funding of the Air Force program which is aimed at eventual development of a Space bomber.

• • •

Meantime, *Mrs. V* . . .

the ARPA study program on maneuverable space vehicles, has moved to the Air Force. It has been incorporated in the *Dyna-Soar* program.

• • •

More mobile air defense . . .

is now planned by the Army. R&D work to make Western Electric's *Nike-Hercules* a mobile field unit is already underway.

• • •

Some new names . . .

worth keeping in mind:

. . . Project 3059—the Air Force code name given to feasibility studies on a 1-million-to-2-million-pound-thrust solid rocket motor.

. . . Notsnik—the nickname given to Navy R&D satellites launched from aircraft at the Navy Ordnance Test Station.

• • •

Project *Orion* is moving . . .

from ARPA to the Air Force. However, the project—aimed at development of a controlled nuclear-blast rocket—faces a dead end unless the moratorium on nuclear testing is lifted.

• • •

Missile shopping lists . . .

for Army hardware—in volume, of course—are now carrying these approximate prices:

. . . Convair *Redeyes*—$6500 each.

. . . Emerson *Little Johns*—$8000 each.

. . . Jet Propulsion Laboratory/Sperry *Sergeants*—$405,000 each.

. . . Douglas *Honest Johns*—$25,000 each including warheads.

. . . *Davy Crocketts*—$1400 each.

• • •

A better *Bullpup* . . .

—the old White Lance project—is being planned by the Navy for the Air Force. Thiokol has a $2-million contract to develop a new *Bullpup* engine expected to double the Martin air-to-surface missile's 4 to 8 mile range. The engine—a pre-packaged liquid—is called Guardian III. The missile will be nuclear tipped.

AT NASA

Test Pilot Joe Walker . . .

will be the first to fly the North American *X-15* recently turned over to the Air Force and NASA. Plans called for a first flight by about March 20, but there may be a delay. Rodgers Dry Lake near Edwards AFB may not be firm enough for landing because of rains.

• • •

Launching of *Thor-Able IV* . . .

and its payload bound for Venus' orbit has been definitely scheduled between March 8-11. If the long-delayed shot is successful, the payload will be named *Pioneer V*.

• • •

No TV scanner . . .

will be carried by *Thor-Able IV* as previously planned. STL removed it because the payload will not pass close enough to anything to photograph.

INTERNATIONAL

Seven Soviet missile cruisers . . .

are reported by the Swedish Navy to be operating out of Baltic ports. The Red ships are reported to be armed with short-range surface-to-surface missiles and what appear to be large liquid-propelled missiles.

• • •

Japanese *Nike-Ajax* sites . . .

are to be located at Keihin, Nagoya, Kelhanshin and Kammon. Four *Nike-Hercules* sites are planned for cities on Honshu. *Hawk* battalions also are planned to be stationed at Keihin.

• • •

A British 'flying telescope' . . .

will be launched in a *Skylark* research rocket from Australia's Woomera Test Range. The rocket payload—developed by a London University research group—will transmit pictures to earth from an altitude of about 100 miles.

• • •

Japanese space scientists . . .

are planning to visit the United States to discuss a U.S.-Japanese program of space exploration. U.S. boosters probably would be used to launch Japanese payloads for some projects.

He put a new twist in an old trick

His problem was to take a 3"x6"x 3-foot piece of wave guide tubing made of .08-inch thick aluminum and to twist one end 90° to the other *without buckling or stretching any part of it...so that a cross section taken anywhere along its length remained a perfect rectangle.*

The standard solution for a problem like this: Support the tube internally with a solder-like substance that's melted in, cooled, melted out after twisting. It won't work here because the mass of the substance is too great.

Here's how this AMF production engineer found the answer. First, he visualized the concept that, in any symmetrical twist, *the center axis never moves.* Then he applied this concept by stringing a metal rod through the center of 288 rectangular shims, inserted them in the tube, cushioned them with the same solder-like substance. Jaws clamp on either end. One of them rotates *slowly* (twisting time: over 2 minutes) giving the metal time to flow. The result: Perfect twists, every time.

Single Command Concept

This bit of production know-how is a sample of the ingenuity AMF brings to every assignment.

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Industry Countdown

MANUFACTURING

Major shift in nose cone . . .
configuration for ICBM's to resemble that of *Polaris* may be in the making. Sharp-eyed observers note Avco re-entry vehicle aboard a recent *Titan* was almost identical to the blunt, tubular *Polaris* model, which is a heat-sink type.

• • •

One-a-week *Titan* . . .
test flights are about to start at Cape Canaveral in a big push to make up time lost during series of failures last year.

• • •

Concrete is being poured . . .
at three of nine new single *Atlas* sites, which will be dispersed in a 60-mile radius of Cheyenne, Wyo. The launchers—all "Hollywood hard" flush with the ground—comprise the third *Atlas* ICBM squadron going in at Warren AFB.

• • •

North American is in on . . .
the formation of a new French company—Dynatom. The co-partners, Societé Alsacienne de Constructions Mecaniques and Chantiers de L'Atlantique, had a major role in developing France's first A-bomb and are expected to work on the development of nuclear warheads for missiles.

• • •

Nord is rolling . . .
on an order for 600 *SS-10* and *SS-11* antitank missiles for Japan. Delivery is scheduled before the end of this year.

• • •

Piping of TV missile . . .
courses from Huntsville to West Point, MIT and the Royal Canadian Military Academy, Kingston, Ont., will start April 7. Students will view the closed-circuit courses on 20 by 12 ft. screens in their classrooms.

PROPULSION

Pre-tensioned, moulded . . .
fibre and resin solid-rocket motor cases up to 60 in. id and 30 ft. in length reportedly can be fabricated under new process patented by National Associates Inc. The cases would have a tensile strength of up to 200,000 psi.

• • •

Blimp transport . . .
of space boosters too big to be moved on the ground (a Goodyear proposal) still interests NASA. But the big hitch is in developing a blimp with high load capacity. *Saturn* is being transported on a barge from Huntsville to the Cape because it's cheaper. NASA, incidentally, has run calculations to determine whether *Saturn* would float if it were filled with hydrogen. It won't.

ASTRIONICS

Plastic radar reflectors . . .
for shipboard Navy *Tartar* missiles being produced by Republic under a Raytheon contract reportedly weigh 325 lbs. and can take shock loads up to 160,000 lbs. They are said to have greater strength-to-size ratio than any previous plastic reflectors made and to operate in winds up to 100 knots.

• • •

Big drive is on . . .
to standardize test procedures for electromagnetic relays. Major step toward removing this obstacle to component qualification was taken recently at a meeting of the American Standards Association and the National Association of Relay Manufacturers in Los Angeles.

• • •

Builders of structures . . .
in space may rightly be called "astrotects." But, if they are on the moon, says Prof. Goettelman, Dean of Architecture at Catholic University, they will no doubt be called "lunatects."

WE HEAR THAT

Britain's defense minister . . .
Harold Watkinson, will arrive in the U.S. shortly to investigate the possibility of buying the *Skybolt* ALBM and the *Polaris* FBM. The British are keenly interested in mobile systems as a replacement for their fixed, land-based *Thor* IRBM's . . . RCA's Harry R. Wege is predicting the United States will require a 75% increase in its engineer force in the next 10 years . . . Successful rocket sled tests of the Autonetic guidance for *Minuteman* may cut down the number of developmental test firings of the missile . . . Temple High Temperature Research Institute's Dr. Aristed V. Grosse suggests changing millions of dollars to "mollars" and billions of dollars to "bollars." Shortening up these incomprehensible figures, he says, would save DOD mollars.

...AND BRISTOL SIDDELE

Bristol Siddeley Engines Limited produce the Thor ramjet. Two Thors power the missile in the Bristol/ Ferranti Bloodhound guided weapon system. This system forms the most effective defence against air attack at very low, up to very high altitudes. And the great flexibility and development potential of the ramjet ensure that Bloodhound will be able to intercept any attacking aircraft for many years to come.

Bloodhound is the RAF's ground-to-air missile system and has been ordered by Sweden and Australia.

The ramjet is the simplest air-breathing engine that has ever been devised and the Thor is virtually a stainless steel tube which can be lifted by two men. A thrust of over 20,000 lb at Mach 3 can be expected from a typical ramjet of the Thor's size.

At speeds of Mach 2.5 and upwards, the ramjet has a lower specific fuel consumption and a lighter weight than any other prime mover, and the higher the speed the greater its efficiency. It is the most efficient powerplant for long-range flight at high supersonic speeds within the earth's atmosphere.

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Defense study finds . . .

Future ICBM's Look Unstoppable

Twelve-company program sponsored by ARPA finds science today has no answers

by James A. Fusca

NEW YORK—Results of a search for effective methods of defending the United States against attack by the sophisticated ballistic missiles of 1970-80 era—including investigation of such esoteric weapons as antigravity, antimatter, and the so-called "death rays" of science fiction—indicate that no promising approach exists within the bounds of present-day scientific knowledge.

Ballistic missiles of the '70's probably will be capable of altering their trajectories in flight to change their points of re-entry and targets. They are expected to have nose cones able to glide and maneuver within the atmosphere, and to be equipped with decoys to be sent out in clouds to confuse antimissile defense systems.

The 12-company study program that has investigated these problems, called GLIPAR for Guide Line Identification Program for Antimissile Research, has been conducted under the sponsorship of the Advanced Research Projects Agency. The final report of a nine-month program which ended last month is now being edited and will probably be published next month.

The GLIPAR program is part of ARPA's Project *Defender*, under which the agency conducts research and development leading to advanced capabilities in ballistic missile defense. GLIPAR, however, has been aimed at setting out initial guide lines for research to develop such a capability for the period between 1970 and 1980.

In the course of the GLIPAR program, a large number of potentially applicable physical mechanisms have been studied with the objective of identifying and assigning a relative value of the mechanisms with the maximum defense potential. The conclusion reached in the final report is that no approach investigated appears promising, the great majority are rated as hopeless, and a few are considered to be worthy of further study because of the lack of present knowledge.

The wide variety of physical mechanisms studied were grouped for convenience into classes, although frequently one approach might overlap into several categories. In general, these classes are:

- **Fields**—In this class are included gravitational, magnetic, magnetohydrodynamic, and nuclear fields. Also included is antigravity, defined for the purposes of the GLIPAR program as any mechanism modifying existing gravitational fields. The study analyzed the effects of these fields both on a re-entry body and on its contained warhead.
- **Plasmas**—Plasmas, or largely ionized hot gases, were studied from several points of view. A hot plasma might cook a re-entry body; the plasma would be capable of transmitting magnetohydrodynamic waves; while passage through these magnetic fields might induce eddy currents in the re-entry body that would cause heating, plus generating mechanical forces that might cause dynamic instability.

Another effect that was examined within this classification was ball lightning, usually associated with thunderstorms. Ball lightning has been proposed as a general weapon both here and in the Soviet Union, but on a scientific basis does not appear to have very much potential.

- **Solid material impact**—Within this class the orbiting of large numbers of solid particles was studied, ranging in size from grains of sand which might erode the missile nose cone and cause it to overheat to objects with enough inertia to cause direct physical damage.

One problem of this approach is that this pellet screen would affect the launching of friendly missiles; another, and more important, problem is that the Soviet Union could blast a hole in the screen over its own territory and drop missiles through this hole while it is over the United States.

- **Particle beams**—Under this classification the effects of beams of protons, electrons, neutrons, and gamma rays were studied. Also included in this group were antimatter beams, including antiprotons, anti-electrons and antineutrons.
- **Optical beams**—These beams divide on the basis of frequency into infrared, visible, and ultraviolet. Neither infrared nor visible light beams appear to have any promise, while not enough is known about the ultraviolet part of the spectrum.
- **Radio frequency beams**—One of the unknowns in attempting to heat a re-entry body by means of a powerful beam of radio energy is the interaction of the electromagnetic energy with the plasma sheath generated around the body during re-entry.
- **Cold gases**—One method of employing cold, or low kinetic energy, gases would be to poison the atmosphere where a nose cone will re-enter with a highly re-active chemical such as hydrogen fluoride. This would have no effect, however, if the nose cone was coated with a non-reactive plastic.

Another method of defense considered was the use of combinations of two or more different techniques. If one defense mechanism was easily countermeasured, the second technique might be selected to take advantage of the countermeasure system. At present, no combination of two defensive techniques that will produce this result has been found, but future studies may be expected to examine three or more defense approaches used in combination.

One of the more unusual approaches proposed as part of GLIPAR was the detonation of very-large-yield hydrogen weapons above an incoming missile along its flight trajectory to irradiate it with large doses of X-rays. Neglecting casualties over a period of time from fallout, estimates of the instantaneous casualties due to ultraviolet radiation made by other scientists on the GLIPAR program range up to and over 10% of the country's total population.

Program Organization

Phase I part of the GLIPAR program, which has taken nine months and cost about $1.6 million, was divided

---

The GLIPAR program has been directed by Dr. Ward Low of the Ballistic Missile Defense Branch of ARPA's institute for Defense Analyses. Contractors on the program have been:

Radio Corp. of America's Defense Electronics Products Div.
University of Chicago's Laboratories for Applied Sciences
General Mills, Mechanical Div.
Thompson Ramo Wooldridge, Inc.
Technical Operations, Inc.
Republic Aviation Corp., Missile Systems Div.
Aeronutronic Div., Ford Motor Co.
Allied Research Associates, Inc.
Hughes Aircraft Co.
General Electric's Defense Electronics Div.
Convair Div. of General Dynamics
Industrial Research Associates, Inc.

into two periods. During the first seven months the 12 contractors conducted individual studies in their own laboratories and wrote a report on the results.

For the last two months of the program, January and February of this year, the contractors have provided representatives to a study meeting at the Presidio in San Francisco. During the first month the individual results were examined and compared, and a first draft of a final report prepared. These representatives then spent a week at their home laboratory, where the assembled results were examined by all project personnel. The remainder of the last month was spent in a final evaluation of program results and a second drafting of the final report.

On the basis of the results of Phase I, ARPA officials doubt that a Phase II follow-on of the program will be required. Their opinion is that the original purpose of the program—discovering those directions in which future research may possibly yield some return—has been fulfilled.

GAD Says NASA Withheld F-1 Capsule Contract Data

The Rocketdyne Division of North American Aviation negotiated a 6½% fixed fee of $6,254,145 to develop the nation's first F-1 single-chamber 1.5-million-lb.-thrust rocket booster for an estimated $96,217,616.

McDonnell Aircraft Corp. negotiated a 6.28% fixed fee of $1,150,000 on an estimated cost of $18,300,000 to develop the Project *Mercury* space capsule.

The fixed fees were disclosed last week in General Accounting Office reports to the House Space Committee, in which GAO complained that in both contracts NASA refused to surrender to GAO recommendations of its Source Selection Boards for audit. NASA, it was revealed in hearings held during January, invoked its executive privilege on grounds that the Board recommendations were merely personal judgments of subordinates.

NASA Administrator Dr. T. Keith Glennan testified that he had established a policy of personally deciding the award of all contracts over $1 million. (Contracts under that amount are awarded on the decision of the Source Selection Board.)

• **Tempered criticism**—GAO insisted that the NASA cloak of secrecy hampered its audit, but the Congressional "watchdog" agency said that the procedures followed by NASA in evaluating the cost substantiation submitted by Rocketdyne were "satisfactory." GAO also conceded that the money estimates also may not have been the significant factor in the winning proposal. Seven bidders were invited to the Oct. 14, 1958, contract briefing, and all but one—Bell Aircraft—submitted proposals.

GAO said that Aerojet-General proposed four programs. Its "Program A" estimate was $98,627,490 with a fixed 7% fee of $6,900,000. The other program estimates were progressively higher, according to GAO. A-G estimates included facility modifications, as did Rocketdyne's.

General Electric proposed a four-phase program and estimated a separate cost for each phase. The total was $190,010,900, with a proposed 8% fee of $15,200,700. Pratt & Whitney Div. of United Aircraft, GAO reported, submitted detailed cost for three development programs, which called for construction of test stands. Including a 7% fixed fee, P&W summarized its proposals as: $61,972,321, the 3½-year program; $105,354,678, the 4½-year program, and $89,354,678, the 5½-year program.

The GAO report said, "Reaction Motors stated in its proposal that its in-house facilities were not adequate for the development of all the components of the proposed engine, and that it had, therefore, arranged to subcontract injector and thrust chamber fabrication to the Convair Division of General Dynamics Corp., San Diego, and to the Solar Aircraft Co., San Diego, and to subcontract the fabrication and initial testing of the turbopump to the Allison Div. of General Motors . . ." Exclusive of propellants, Reaction offered a proposal of $179,674,474, with a fixed 9% fee totaling $16,170,692. Total estimated cost, including propellants and fixed fee, would be $211,-136,387.

Wright Aeronautical Division of Curtiss-Wright Corp. submitted a proposal for development of a "liquid turborocket engine" which would use a liquid oxygen hydrocarbon fuel and would develop nominal thrust of 1 million lbs. at sea level. The firm, GAO said, proposed construction of new development and test facilities. "Curtiss-Wright proposed that the Government construct the liquid oxygen plant and that the relative portion of the remaining costs to be borne by the Government and C-W be determined by negotiation," said GAO. Estimated cost of facilities was $52- to $55-million; and exclusive of these, the C-W bid, with propellants and a fixed 7% fee would be $92,270,516.

• **'Parallel procedure'**—In a separate report, GAO said the "procedure followed in selecting the successful proposal for the Project *Mercury* capsule parallels the principle and procedure used in selecting the successful proposal for development of the 1-million-lb.-thrust rocket engine." The agency said it believed the Source Selection Board data was needed to conduct a proper review. But it wrote that "documents in the contract file indicate that the contracting officer made proper use of the services available to him in determining the reasonableness of the McDonnell estimate of the reimbursable cost; that those elements of the cost estimated which were based upon the contractor's cost experience were reviewed at the McDonnell plant, that those elements of the cost estimated which were based upon engineering estimates of the requirements of the program were reviewed by technical personnel of NASA, and that questions raised as the result of those reviews were satisfactorily resolved."

—news briefs—

• **Cape Canaveral**—The Air Force postponed a 9000-mile *Atlas* shot into the southern Indian Ocean on March 1. There was no official explanation, but there were reports that the launch was called off at least temporarily because of possible international political implications.

• **Washington**—NASA created a new Office of Life Sciences and named Dr. Clark T. Randt to head it. The new office—described by NASA as "a fifth major division"—covers the fields of biology, medicine and psychology.

• **London**—Britain is understood to have decided to add mobile missile launchers to its missile arsenal. British defense officials are believed to be interested in possible adoption of the Lockheed *Polaris* and the Douglas *Skybolt*.

• **Helsinki**—A tremendous explosion is reported to have blasted a Soviet ICBM base near Alakkrtti close to the Russo-Finnish border. Sources said they believed the blast was a nuclear explosion.

• **Washington**—The House Science and Astronautics Committee last week approved the $915 million FY '61 budget authorization request for NASA in total informing the space agency that it could ask for more later in the year if necessary. The bill will be brought to the floor of the House March 7. Early passage is expected.

Weaponry Lesson: 2 Yrs. for *Pershing*

First flight for 'crash program' bird successful; longer shot due shortly

by Heather MacKinnon

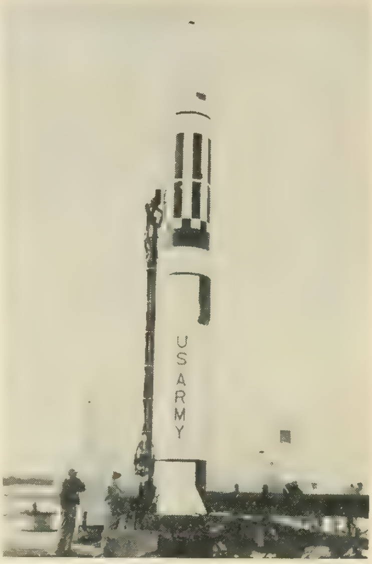
Less than two years after the initial contract was announced, The Martin Co.'s *Pershing* was successfully fired Feb. 25 in its first free-flight test by the U.S. Army.

Shot from its combination transporter-launcher at Cape Canaveral, the two-stage MRBM traveled a programed 30 miles down the Atlantic Missile Range. Although total capability is estimated to be about 500 miles, the Army test vehicle carried a dummy second stage and was not separated. Later tests will add refinements, more detailed objectives and longer ranges, in accordance with the Army "progressive firing objectives."

Cloaked in mystery, the solid-propellant bird has the highest priority of any missile in the Army program, and represents a $200-million investment. An additional $118 million in the FY '60 budget is earmarked for continued research and development by Martin.

Pershing was developed by Martin with only technical supervision of the Army Ballistic Missile Agency to replace *Redstone*, which has been deployed with overseas troops since 1958. It is designed to have a short reaction time, versatility in all types of terrain and climate, and be lighter, smaller and even more mobile than its predecessor.

• **Description**—Although little has been officially made public, it is generally recognized that the missile is about 40 feet long, 24 inches in diameter and solid-propelled. Thiokol Chemical Corp. at Huntsville, Ala., designed and developed the two-stage propulsion system. Fuzing and arming of the nuclear warhead is subcontracted to Bulova Watch Co.



PERSHING and "TEL," its unique transporter-erector-launcher, are easily transported and maneuvered by ground troops.

Bendix Eclipse-Pioneer Division has received the subcontract for an inertial guidance stable platform and associated equipment, which will eliminate the possibility of outside jamming. The system is reported to be similar to those used in *Redstone* and *Jupiter*.

• **New transporter-launcher**—*Pershing* will have a "shoot and scoot" capability, thanks to a unique transporter-erector-launcher (TEL) built by Thompson Ramo-Wooldridge, Inc. With four wheels and pneumatic tires, the vehicle can be towed across rough terrain and easily maneuvered into firing position.

During transport, the missile is carried in a horizontal position on the dual track erector. When ready to fire, the launching platform mounted at the rear of the vehicle rotates to the ground and is leveled, the erector raises to the vertical position, and the missile is placed on the launcher. When the erector returns to a horizontal position, the missile is in place in a vertical position on the azimuth ring of the launcher. The azimuth position is then adjusted and checked and the bird is ready to go—all within a few minutes.

A cable mast mounted in a bracket attached to the launcher azimuth ring at one end and engaged with electrical and air connections in the missile at the other, contains control cables, air ducts and high-pressure air lines.

After these lines are used to precondition, checkout and fire, the cable is automatically disconnected from the missile, and held in a near-vertical position by a brake. With this feature, the cable is prevented from falling or being destroyed during firing, and thus can be used again.

Countdown and launch activity is accomplished from a tracked vehicle transported fire control hut, where test and checkout equipment also is housed.

The entire system is transportable by either helicopter or aircraft.

M/R Opens New York News Bureau

Missiles and Rockets has expanded its news and technical coverage in the New York and New England areas with the opening of a new editorial bureau in New York City under the direction of James A. Fusca.

M/R's four previously established bureaus are in Los Angeles, Geneva, Paris and London.

Prior to joining M/R, Fusca was an electronics editor for Aviation Week. Earlier, he was an engineer with Reeves Instrument Corp., Melpar, Inc., and RCA. He was also a supervisor of government research projects with Radiation Research Corp., and served as Technical Advisor for the Military Assistance Advisory Group of the U.S. Embassy in Brussels. A graduate engineer of Columbia University, Fusca is a member of IRE and the American Rocket Society and serves on two committees on radio navigation for the Radio Technical Commission for Aeronautics.

The new editorial office is at 20 East 46th Street, New York 17, N.Y. Telephone number is Yukon 6-3900.

Bullpup ASM Getting Nuclear Warhead

Bullpup is getting some teeth—a nuclear warhead to be developed under a new $4.5-million AF contract, according to Martin spokesmen. The new warhead will be interchangeable with the conventional one to be used in *GAM-83B*, an advanced model.

In addition, a new electronics control package has been developed for both *GAM-83A* and *GAM-83B*, permitting the launching of the missile from planes while they are flying parallel to the target, making a dive unnecessary. Studies also are under way for an improved guidance system to be incorporated into *GAM-83B*.

Bullpup was first developed as an air-to-surface missile *(ASM-N-7)* by Martin-Orlando for the Navy and is operational with the Fleet. *GAM-83A* grew out of the Navy version.

Missiles and Rockets

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since January 4 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
★AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout	Used in DISCOVERER program; larger model to be used with ATLAS and THOR under development; NASA also will use to take place of cancelled VEGA
★ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	Two lunar orbit attempts this spring and summer
★CENTAUR (NASA)	Convair, prime; Pratt & Whitney/JPL, propulsion	Soft-land 730-lb. on moon; first liquid hydrogen engine; 30,000-lbs. of thrust	First test flight in spring, 1961
COURIER (ARPA-Army)	Army Signal Corps, prime	Delayed repeater communications satellite	R&D; satellite in advanced stage; first to be launched in spring
DECREE (ARPA)	No contract announced	24-hour instantaneous repeater satellite	R&D
★DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA launchings of early stabilized satellites	Of first 10 launched, 5 stabilized in orbit; ejected capsules not recovered
DYNA-SOAR I (Air Force)	Boeing, space craft and systems integrator; Martin, propulsion	Boost-glide orbital space craft; first space bomber; TITAN booster	R&D; first glider flights from Edwards AFB by 1962
★ECHO (NASA)	Langley Research Center, prime	Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite	First launch this spring
JUNO II (NASA)	ABMA/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, prop.	Early deep space booster; small payload	Five more shots planned
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite	Capsule tests on ATLAS to begin; manned capsule launching by REDSTONE down Atlantic this Summer; first manned flight scheduled in 1961
★MIDAS (Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites	R&D; early launchings from Cape; later from Pacific Missile Range's Point Arguello; transferred from ARPA to Air Force; first R&D launching Feb. 26 failed because of apparent trouble in second stage
MRS. V. (Air Force)	No contract announced	Manueverable, recoverable space vehicle; also known as DYNA-SOAR II	Turned over to Air Force as part of Dyna-Soar program.
★NOVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-9 million lb. booster plus upper stages	Early R&D on 1.5 million lb. F-1 engines
★ORION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted; program to be shifted to Air Force alone
PROJECT 3059	No contracts announced	Solid motor in 1 million to 2 million lb. thrust class	Research aimed at determining feasibility

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY	R&D; stabilization already achieved in DISCOVERER series; first test launching scheduled this spring; transferred from ARPA to Air Force
★SATURN (NASA)	NASA Huntsville Facility, prime; Rocketdyne, Pratt & Whitney, propulsion; others not announced	Five-stage vehicle with 1.5-million-lb. clustered booster. Second stage to be cluster of four 200,000-lb. liquid hydrogen engines; third, two 200-K engines; fourth, four 20-K's; fifth, two 20-K's	New timetable: first static firing this month; first flight late 1961; first operational flight 1963 with 4th and 5th stages on booster
★SCOUT (NASA-Air Force)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Allegany/Thiokol, propulsion	Solid four-stage satellite launcher; 200-300 lb. payload in orbit	Operational this summer; Air Force and probably Navy also to use for research
STEER (ARPA)	GE-Bendix, prime	Polar-orbiting instantaneous repeater satellite	R&D
TACKLE (ARPA)	No contract announced	Polar orbiting communications satellite	R&D
★THOR-ABLE (NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Early deep space booster	Sun orbit shot in Spring—nine months behind schedule. Only two shots left in program
★THOR-DELTA (NASA)	STL, prime; IT&T, guidance; Rocketdyne/Aerojet-General/Allegany,prop.	Put 65-lb. satellite in orbit around moon	R&D; first flight early this year; to be used in ECHO and TIROS program
★TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover	R&D; three launchings this spring; international politics stalling program
★TRANSIT (ARPA-Navy)	Johns Hopkins Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50 lbs.	First shot almost complete failure because final stage didn't operate; second shot slipped to March
TRIBE (ARPA)		Family of space launching vehicles	Planning
★YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	Studies
★X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 3600 mph; flight at edge of space; on AF model each XLR-11 rocket engines develop 16,000 lbs. of thrust; later XLR-99 engines to develop 50,000 lbs.	Five powered flights; one plane damaged in landing; second plane hit Mach 2 and more than 80,000 ft Feb. 11; first X-15 has been accepted by the Air Force, turned over to NASA for testing at Edwards AFB

MISSILES & ROCKETS

ABLE (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional	Deployed on destroyer escorts
ASROC (Navy)	Minneapolis-Honeywell, prime	Surface-to-underwater; solid rocket torpedo; nuclear	R&D; operational Jan. 1961
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	ICBM; more than 5500-mile range; liquid; nuclear	41 military launchings: 25 successes, 8 partial, 8 failures; 4 scientific launchings; 4 successes. Two operational at Vandenburg; 11 of 13 sites named
AUTOMET (Army)	No contract announced	New solid tactical missile	R&D; test vehicle stage
★ARM (Air Force)	No contract announced	Anti-radar missile	R&D
★BOMARC-A (Air Force)	Boeing, prime; Westinghouse, guidance; Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 m. range; Mach 2.7; nuclear	First squadron operational at McGuire AFB, N.J.
BOMARC-B (Air Force)	Boeing, prime; Westinghouse, guidance; Thiokol, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 500 m. range; nuclear	Late development stage
★BULLPUP (Navy-Air Force)	Martin, prime; Republic, guidance; Thiokol (Reaction motors), propulsion	Air-to-surface; 4-8 mile range; conventional 250-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model under development	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor	24.6-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines evaluating for purchase; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CORVUS (Navy)	Temco, prime; W. L. Maxson guidance; Reaction Motors, propulsion	Air-to-surface; pre-packaged liquid; radar homing; about 100-miles range	First successful test July 18, 1959
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
★DAVY CROCKETT (Army)	In-house project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead	R&D; operational in FY '61
EAGLE (Navy)	Bendix, prime; Sanders, guidance; Aerojet propulsion	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow aircraft	Early R&D
FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional	GAR-1D & GAR-2A & GAR-3 operational; GAR-4 & GAR-9 under R&D; GAR-9 work slowed
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
★HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; units training for early deployment to Europe and Far East; advanced Hawk under development; Jan. 29 successfully intercepted Honest John, first known intercept of one tactical missile by another.
HONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-mile range; nuclear	Operational; deployed in Europe
★HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; training fully underway
★JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear, reentry vehicle	IRBM; liquid; nuclear	To be deployed with Italian troops in Italy and used as AICBM target drone; 29 military launchings: 22 successes; 5 partials; 2 failures. One 15-bird squadron to be deployed in Turkey. Last R&D test shot launched Feb. 4
★LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960; to be deployed in Europe and Far East; advanced LACROSSE R&D program dropped at least temporarily
LITTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Operational this year; units training with it
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm	Studies
LULU (Navy)	No contract announced	Surface-to-surface; nuclear	R&D
★MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
MAULER (Army)	Convair; prime	Surface-to-air; IR guidance; field weapon	R&D
★MINUTEMAN (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Avco, re-entry vehicle; AMF, rail launcher	2nd generation ICBM; solid; mobile; nuclear; 3 stages	R&D. Expected to be operational by late 1962 and deployed in 1963; to be installed in hardened sites and made mobile on trains, possibly trucks; five tethered full-scale test models successfully fired from silos

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★MISSILE A (Army)	ARGMA to act as prime; six R&D contracts for components scheduled to be let soon	Surface-to-surface; 65-70 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear; claimed effective against air-launched air-breathing missiles	Rapidly replacing NIKE-AJAX
★NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol and Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands at the rate of about one a month beginning Aug. 26. Four launchings: 3 successful, 1 partial. Test shots in the Pacific against drone missiles planned in mid-1961. Administration has refused to okay Army recommendation to begin production.
★PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; solid; under 700-mile range; nuclear	R&D; to replace REDSTONE; first R&D launching Feb. 25 from Cape a success; 35 miles as programmed
★POLARIS (Navy)	Lockheed, prime; GE, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear	52 launchings of test vehicle; 35 successes; 15 partial; 2 failures; launched from surface ship Aug. 27, 1959; expected operational late in 1960; fully guided 900-m. range vehicles under test at Cape Canaveral
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	Convair, prime; Atlantic Research, propulsion	Surface-to-air; 20-lb. bazooka-type; IR guidance; solid; conventional	R&D
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe
REGULUS II (Navy)	Chance Vought, prime; Stavid, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; used as target drone
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORAL this year
SHILLELAGH (Army)	Aeronutronics, prime	Surface-to-surface; lightweight; can be vehicle-mounted	R&D; expected to be operational mid-1960's
SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional	Deployed with Navy and Air Force; all-weather type under development
★SKYBOLT (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion	Air launched ballistic missile; more than 1000-mile range; solid; nuclear	R&D contract let
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	Deployed at Presque Isle, Maine
★SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8-mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; earlier SPARROW I obsolete; new contract aimed at extending range and altitude
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-50 mile range; solid; nuclear	R&D
SUPER TALOS (Navy)	No contract announced	Seagoing anti-missile missile; possible AICBM	Early R&D
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation by Army.
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Many test firings in Pacific; expected deployment 1960 as primary armament of guided missile destroyers; production
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet
★TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational Advanced TERRIERS to be deployed about mid-1960
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, reentry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England. 61 military launchings: 42 successes; 11 partial; 8 failures; 24 scientific launchings; 19 successful, 3 partial; 2 failures; R&D and "hot rod" advanced tests completed Feb. 29.
★TITAN (Air Force)	Martin, prime; Bell, Remington Rand, guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear	9 launchings test vehicles: 6 successes; 3 failures; program slipping
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

SATELLITES

SATELLITE	COUNTRY	STATUS
EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 224 m., apogee: 1573 m., period 114.8 min. (Discovered Van Allen Belt)
VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 409 m., apogee: 2453 m.
★SPUTNIK III (about 3.5 tons)	Russia	Launched 5/15/58, est. life, 11 mo. Orbits earth, perigee: 135 m., apogee: 1167, period: 106 min., inclination to equator: 65.3°. Speed, at perigee: 18,837, at apogee: 14,637 mph.
LUNIK I "MECHTA" (3245 lbs.)	Russia	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle.
VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 347 m., apogee: 2064, period: 125.85 min., inclination to equator: 32.88°.
PIONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory.
★EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life: to Aug. 1961. Orbits earth, perigee: 156 m., apogee: 26,357 m., period: 12½ hours, speed: at perigee 23,031, at apogee: 3126 mph., inclination to equator: 46.9°.
VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 319 m., apogee: 2329 m.
LUNIK III (about 614 lbs.)	Russia	Launched 10/4/59, est. long life, orbits earth-moon; took first picture far side of moon; est. perigee: 30,000 m., apogee: 291,000 m.
EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 341, apogee: 679.
★DISCOVERER V CAPSULE (less than 300 lbs.)	U.S.	Launched 8/13/59. Satellite burned up in atmosphere Sept. 28. Capsule also thought to have been destroyed, but it was later rediscovered and first thought to be an unidentified Soviet satellite. Est. life several months, perigee: 134, apogee: 1074.
★DISCOVERER VIII	U.S.	Launched 11/20/59, est. life 2-3 months, perigee: 116, apogee: 913.

Reprints Available

Since Missiles and Rockets Magazine first started giving a bimonthly report on the status of space vehicles and missiles and rockets, numerous readers have asked about the availability of reprints.

The following charges are established:

1 to 100 copies—20¢ each
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Shepherd Touching Off Interservice Row

ARPA's 'dark satellite' detection system still 'unassigned' although all three services have phases of the program

by Hal Gettings

Baa, baa, Shepherd, *have you any gold?*
Yes sir, yes sir, three bags full:
One for the Army; one for the Navy;
And one for the little ol' Air Force.

Project *Shepherd,* ARPA's "dark satellite" detection system, is apparently scheduled for a round or two of interservice rivalry. Already overdue for assignment to one of the military services, the program is still in the research and development stage—the assignment date remains somewhere in the future.

Familiarly known as "Insect" (INSSCC—Interim National Space Surveillance Control Center), the project's primary function is to develop a means to detect and track "dark," or passive, satellites passing over the U.S. These include known satellites whose transmitters no longer emit radio signals and unannounced "enemy" satellites which could be used for reconnaissance.

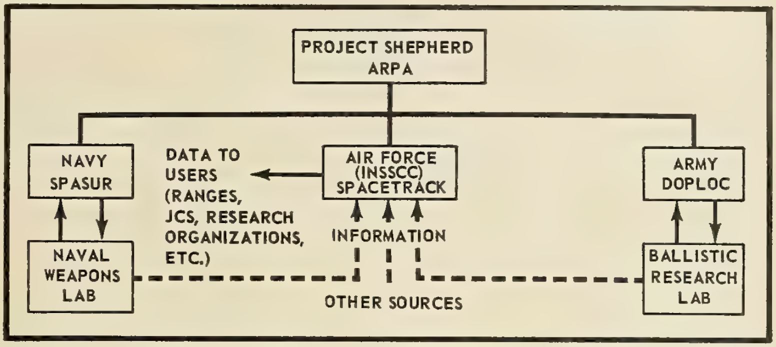
The system recently moved into the limelight when the Department of Defense announced the detection and tracking of an "unknown" satellite on Feb. 10. INSSCC successfully tracked the satellite and computed orbit parameters and life expectancy.

• **Three services involved**—All three services are presently involved in Project *Shepherd.* Navy has two east-west detection complexes (see map) and an R&D computation center at Dahlgren Naval Weapons Lab.

Army, with its "Doploc" fence—an alternate receiver system—fills in the center of the transcontinental system.

Air Force's Air Research and Development Command has set up a computation control center at its Cambridge Research Center which will gather data from the detectors and issue periodic bulletins on all existing satellite orbits. This facility, part of the Spacetrack program, is considered to be in development but is already operational to some extent.

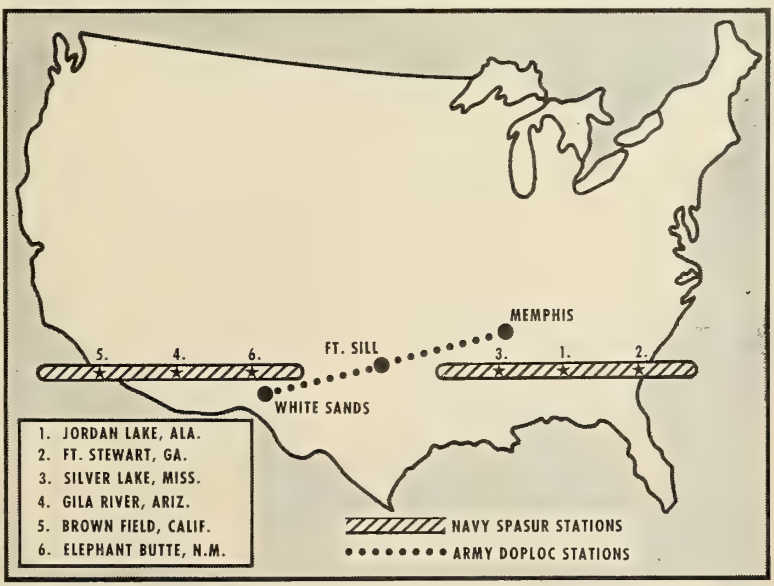
Beyond this point, however, there seems to be considerable confusion as



INTERIM SURVEILLANCE system involves all three services, with ARPA furnishing money and management supervision. Final system will logically be under one service with AF Spacetrack computation center handling all detection data and issuing periodic reports.

to exactly how the system will operate once it's past the interim stage. Army, apparently, may be pretty well out of the picture—its Doploc reportedly hasn't worked too well. Its portion of the fence is presently operating on a reduced schedule. This leaves Navy and Air Force as major contenders for system management.

Aeronutronic Division of Ford Motor Co. has just been awarded an ARDC contract as systems contractor



U.S. east-west fence is composed of two Navy SPASUR installations and one Army Doploc complex.

to study operations of the INSSCC to produce a system design plan for future expansion of the facility. Operational analysis studies on the space surveillance system will include communications, data handling, computation, prediction and observation net control. Eastman Kodak, Page Communications, Dunlap and Associates, and Raytheon are associate contractors.

Funding through Fiscal '60 totals approximately $31.5 million. This year's budget allotted $6 million to Spacetrack and $5.57 million to the Army and Navy combined—which may or may not be indicative of wind direction.

• **So far, so good**—Indications are that ARPA is pleased with the system to date. Developed and built on a crash basis, INSSCC was authorized in June, 1958, and completed in less than a year.

The Navy fence—developed from the *Vanguard* Minitrack—has worked well and results obtained from the interim equipment indicate that an adequate detection and prediction system is quite feasible.

Present performance characteristics are classified. Effective detection ranges are not known, but it is certain that satellites can be put into high enough orbits to escape detection by present equipment. Roy Johnson, former director of ARPA, recently stated that the system would operate out to 1000 miles.

Although evaluation time requirements have not been released, reduction and computational time is probably in the neighborhood of 24 hours. This would apply to both computer facilities since neither has automatic conversion and processing equipment.

• **Improvements needed**—Several things would have to be done to make the system fully operational and adequate to detecting and evaluating possible future satellites. Present operation is limited to space vehicles whose orbits cross the fence (32° North latitude). Satellites crossing the U.S. below this latitude would be undetected. A proposed spur would give wider coverage and faster orbit determination.

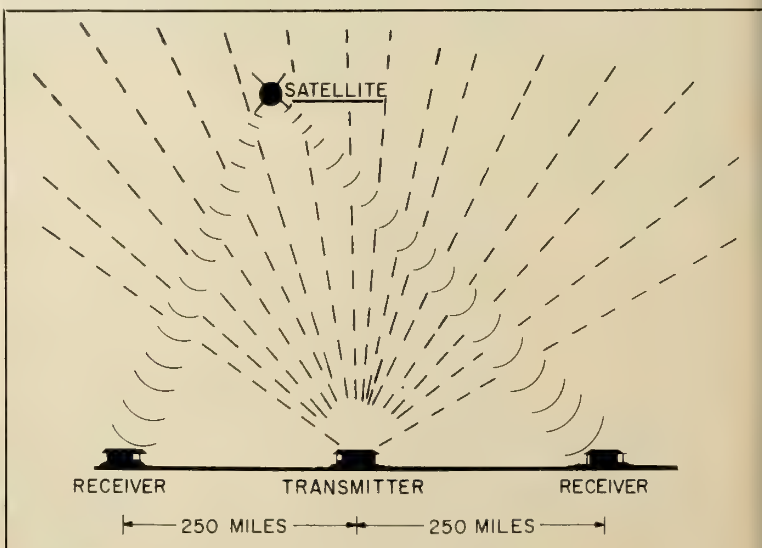
Ranges would be extended by upping the power of the radio transmitters and, possibly, by more sensitive receivers and higher-gain antennas.

Automatic data processing equipment is necessary to cut evaluation time. At present, detection information fed to the filter center must be manually reduced and converted to digital data to enter the NORC and IBM 709 computers. Automatic equipment also would upgrade the quality of input data to provide more precise orbit determination.

Plans for these extensions are extremely hazy at present, however, and neither ARPA nor the military agencies concerned appears willing to make any predictions as to the future of the program.

All involved agree that a satellite detection system such as this is needed. Those concerned with the problem feel that national security demands that we know the precise location at all times of any satellite orbiting around the earth.

• **Friend or foe?**—Detection is, however, only part of the problem. We



TRANSMITTED ENERGY is reflected from satellite to ground receiving stations. Radio interferometer techniques are used to precisely measure direction of received signals.

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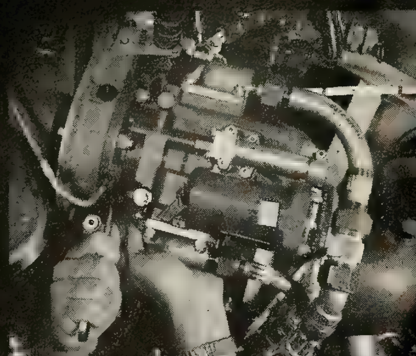

Vickers Pump Being Installed on Atlas

AERO HYDRAULICS DIVISION
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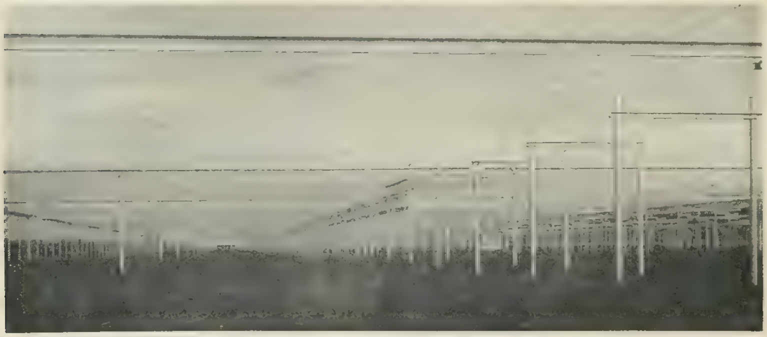
also need to be able to determine the function and operation of a suspected "unfriendly" satellite. And—once its "unfriendliness" is confirmed—what can be done about it.

It is logical to assume that such a vehicle would be disguised as a "peaceful scientific" type, and this compounds the problem. Even if we had the capability, shooting it down would make the U.S. subject to a barrage of unfavorable propaganda. One tongue-in-cheek suggestion to combat such a possibility is to arrange for the unfriendly "scientific" satellite to accidentally collide with another "scientific" satellite. Precisely maneuverable satellites are still somewhere in the future, however; this solution must await considerable refinement in the state of the art.



RECEIVING STATION antenna array is over a quarter-mile long and 300 feet wide.

NAVY USES modified Minitrack transmitting and receiving equipment. Transmitting stations, such as this installation at Jordan Lake, Ala., use 50 kw transmitters on a frequency of 108 mc.

Capt. Winfred Berg, director of the Naval Research Laboratory Space Surveillance program, has stated that the only solution lies in "hiding" from observation by a reconnaissance satellite. Knowing the precise location of the vehicle at all times would allow activities in areas under observation to be disguised, stopped, or changed to reflect a false picture to the observer. In addition, countermeasures might be used to fool the enemy or jam his reception.

• **Operates like radar**—Operation of the detection system is similar to that of radar. A transmitter is located at the center of each portion of the fence—Jordan Lake, Fort Sill, and Gila River. Stations on each side of the transmitter contain the antennas and receivers. The transmitters emit a continuous fan-shaped "curtain" of r-f energy into the sky along the line of receiving stations. The pattern is very narrow in the north-south direction and broad in the east-west. The receivers have similar antenna patterns and all are co-planar with the transmitter pattern so that a satellite entering the transmitter antenna beam also enters the receiver antenna patterns. The two receivers then receive the reflected energy from the satellite as it crosses through their patterns.

The receiving stations have the equipment necessary to measure very precisely the direction from which the satellite reflections arrive at each station. This measurement is accomplished through the use of radio interferometer techniques (Navy Minitrack stations) and doppler effects (Army Doploc stations).

The receiver information is then transmitted to the computation centers for orbital determination. Data from the Navy fence is sent to the Dahlgren facility, to Naval Research Lab, and a portion to the Air Force Spacetrack filter center at Cambridge. Doploc data is transmitted to the Army's Ballistic Research Labs at Aberdeen, Md. Present plans call for the Spacetrack facility to eventually serve as the computation center for all data.

• **Decision called for**—The big question—now that feasibility has been proved and agreement reached as to the necessity for space surveillance—is why nothing further is being done. The present interim system, although working, is certainly not adequate—as proved by its first announced detection of an unknown satellite. Data had been received for a considerable period—possibly several weeks—before the

Orbital Elements of Known Satellites in Orbit as of February 1, 1960

Satellite	Popular Name	Nodal Period (Min)	Inclination (Degrees)	Perigee Height (Statute Miles)	Apogee Height (Statute Miles)	Launch Date
1958 Alpha	Explorer I	108.9	33.2	218	1250	1-31-58
1958 Beta 1	Third Stage Vanguard I	138.2	34.3	402	2680	3-17-58
1958 Beta 2	Vanguard I	133.9	34.3	407	2450	3-17-58
1958 Delta 2	Sputnik III	93.0	65.1	116	410	5-15-58
1959 Alpha 1	Vanguard II	125.5	32.9	346	2050	2-17-59
1959 Alpha 2	Third Stage Vanguard II	129.7	32.9	345	2280	2-17-59
1959 Delta 1	Explorer VI	756.4	47.0	155	26,000	8- 7-59
1959 Delta 2	Final Stage Explorer VI	(Similar to 1959 Delta 1)				8- 7-59
1959 Eta	Vanguard III	130.0	33.4	316	2330	9-18-59
1959 Theta 1	Lunik III	22,700.0	80.5	25,100	297,000	10- 4-59
1959 Theta 2	Final Stage Lunik III	(Similar to 1959 Theta 1)				10- 4-59
1959 Iota 1	Explorer VII	101.2	50.3	346	670	10-13-59
1959 Iota 2	Final Stage Explorer VII	101.2	50.3	343	670	10-13-59
1959 Lambda	Discoverer VIII	96.0	80.7	116	600	11-20-59
Unknown 1-60	Discoverer V	104.5	79.0	134	1074	8-13-59

Navy recognized that a detection had been made. No red lights flashed and no automatic readouts started printing orbit calculations. In other words, the present R&D system requires a high order of skilled human vigilance and interpretation—or "eyeball" technique—to make it work.

The technical problems can be solved. A high-level decision is now in order—to assign the system to one responsible agency, lay out the operational procedures, decide what the final system will be, and appropriate the money to get the job done.

'Phothermionic' Image Converter Developed

A "phothermionic" image converter, an all-electronic device that changes received infrared radiation into a visible picture on a television screen, has been developed for the far-IR spectrum.

Disclosure of the infrared imaging device was made at the winter meeting of the American Institute of Electrical Engineers, by Dr. Max Garbuny, head of the team of Westinghouse research scientists that developed the system. The development was sponsored largely by Wright Air Development Center, U.S. Air Force.

Such radiation (long wavelengths) is emitted by comparatively cool objects such as the human body. Hotter objects, for example those that actually glow red hot, emit more energetic radiations of shorter wavelength in the "near" infrared, and are easier to detect.

The new device is sensitive enough to detect a moving object near room temperature when it exhibits temperature differences of approximately 20°F. This is just about the spread between the temperature of the human body and average room temperature. In addition, the system is fast enough to follow the movement of such objects with the same speed as a normally visible object is followed by the unaided human eye, said Westinghouse.

Key component in the system is a unique infrared-sensitive detector. It is a three-layer sandwich only a few millionths of an inch thick. The center layer of the sandwich is an ultrathin support film of aluminum oxide about one millionth of an inch thick. The film is made by chemically dissolving away all of the aluminum metal in a piece of suitably treated aluminum foil, leaving only the thin layer of aluminum oxide coating the surface of the foil.

The front surface of the oxide support film is coated with an even thinner layer of nickel, deposited in such thickness that it strongly absorbs TR radiation. The back surface of the film is coated with a thin layer of photoemitting material, cesium bismuth.

Of key importance is the fact that the photoemitter's ability to release electrons under the stimulus of light varies with its temperature, changing 2 or 3% for every degree its temperature changes.

To increase the overall sensitivity and performance of the detector, it is cooled to a temperature of about —180°F.

In use, the IR radiation from an object is focused on the heat-absorbing layer of the detector forming a temperature pattern of the image. The temperature pattern is transferred through the thin support layer to the photoemitting surface, where it can be perceived simply by scanning a spot of light across the surface. As the light spot scans the photoemitting surface, many or few electrons flow from the surface in exact conformity to the heat pattern on it. Electrical signals are then amplified and fed to a standard television picture tube.

50-Million-Hour Life Test Program Under Way

Military diodes and transistor life tests are now being performed by Clevite Transistor Products in an attempt to prove parts will function for up to 50 million hours under severe environmental conditions.

The company said tests are under way in its newly equipped reliability lab in Waltham, Mass.

Components are being subjected to

Marquardt ADVANCED PRODUCTION CAPABILITY for air and space

MARQUARDT/OGDEN RAMJETS FOR USAF-BOMARC PROVE 100% RELIABLE

Marquardt/Ogden delivered its first production engine to the Air Force in June 1957, one month ahead of schedule. This was achieved despite the problems of creating, building and implementing a modern production facility and staffing it with qualified engineers and technical personnel. In the more than two years since, each and every delivery has been as-per-contract-schedule, while Ogden ramjets have proved 100% reliable in all test flights of Bomarc IM-99A.

By strict adherence to a realistic learning curve, Ogden Division currently delivers its supersonic ramjets at far less than their mid-1957 delivered cost—this despite the ramjet engine system's relatively early stage of maturity.

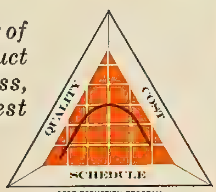
Recent expansion and additions further enhance Marquardt/Ogden's capability. In 1958 the plant doubled floor space to almost ¼ million square feet, with numbers of employees increasing 93%. 1959 marked Ogden Division's addition of a first-of-its-kind Spin Forge and completion of a new facility for explosive metal forming. Ogden's USAF-Marquardt acceptance test facility at Little Mountain gives the Division full-plant capability.

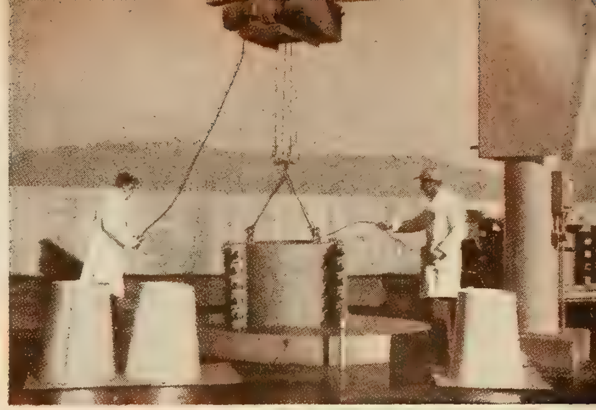
Marquardt/Ogden is now capable of producing space-age hardware in all of its basic configurations—cones, cylinders, rings, parabolic shapes—using the most sophisticated of space-age metals.

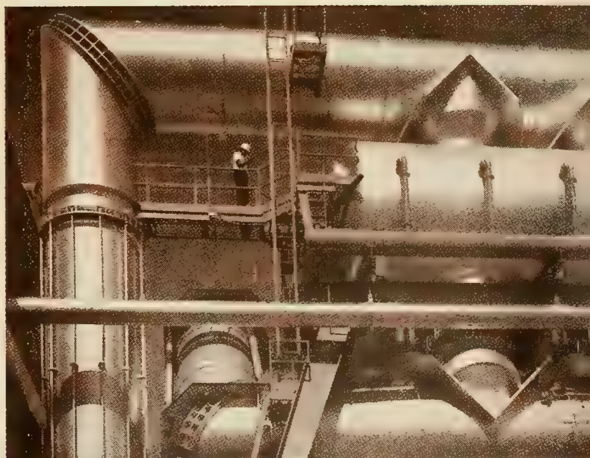
Responsible for Marquardt/Ogden's record are: a creatively cost-conscious management team headed by Mr. D. K. Tasker (pictured left); early application of industry's newest and most advanced production and metal working techniques; a facility cited by *Factory Magazine* as one of America's top ten; and the efforts of the Division's nearly 2,000 men and women workers. All combine to provide Department of Defense and Weapon Systems Managers with a unique capability for the on-time delivery of reliable space-age hardware at minimum cost.

For additional production capability specifics, you are invited to contact: Manager, Customer Relations Department, Ogden Division, The Marquardt Corporation, 1000 West 33rd Street, Ogden, Utah.

Current expansion creates a number of outstanding opportunities for: Product Development, Materials and Process, Manufacturing and Production Test Engineers; and skilled machinists.







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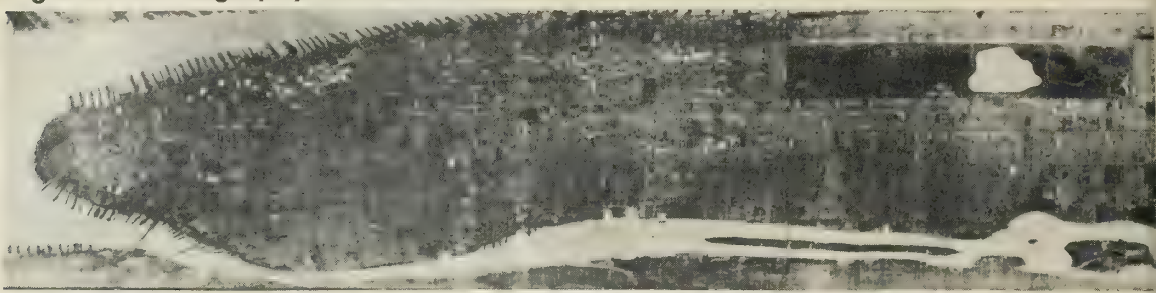
TOP. High energy (explosive) forming produces heretofore "impossible to form" shapes—typifies Marquardt/Ogden's continuing quest for optimum materials and processes which advance the art of metal fabrication.

CENTER. Marquardt/Ogden's massive Spin Forge is the most powerful of its type for cold-flow forming of space-age metals. It compliments the Division's new explosive metal forming facility and other specialized equipment.

BOTTOM. USAF-Marquardt Jet Laboratory-Ogden at Little Mountain, some 15 miles West of Ogden, accept-ance-tests every production engine system produced by the Division; is capable of simulating flight at speeds in excess of Mach 3, altitudes above 100,000 feet.

Nighttime Photography with Infrared



JUST DECLASSIFIED BY DOD, this detailed nighttime infrared photo of Manhattan Island, was taken with an HRB-Singer, Inc. Reconofax from 4000 ft. Reconofax makes use of a scanning camera with an improved detector. Note clear definition of roads and paths in Central Park and detection of ships in the Hudson and East Rivers.

shock, vibration and stresses by equipment calculated to guarantee a more rugged treatment than would be experienced in missile blast-off or re-entry.

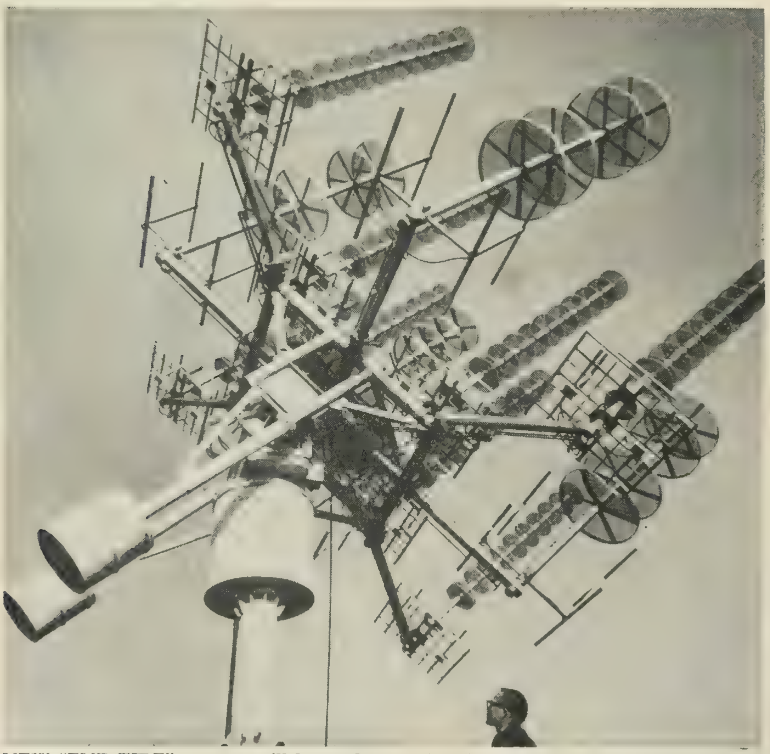
They also are baked, frozen, soaked and exposed to corrosive chemicals to test resistance to climate extremes.

Before this exposure, components are tested to meet rigid performance specifications. If they perform to the same specifications at the final check-out, they are approved as being of highest reliability. Final check-out includes visual examination under 30-power optical magnification.

In three programs now under way, diodes are tested from two weeks to a month and a complete history is recorded. Ultimately, data processing equipment will be used to analyze millions of individual histories to predict life potentials under various usages.

It is hoped that knowledge gained through reliability tests will make it possible to improve numerous electronics systems, particularly for future space stations, global communications and missile systems.

Antenna for Tiros



NEW "END-FIRE" antenna will be used to receive signals from NASA's Project *Tiros* meteorological satellite. Unique antenna, designed and developed by General Bronze Electronics, will be delivered to RCA-Princeton, one of the prime contractors in the satellite program.

Navy Tests Full-Scale *Polaris* Guidance System

The first full-scale test of a complete inertial guidance system for the *Polaris* missile was made Jan. 7 from Cape Canaveral, the Navy has announced. Three succeeding shots also have been successful, covering a distance of 900 miles. The last of these flights, on Feb. 10, brought into further prominence the role of the Massachusetts Institute of Technology's Instrumentation Laboratory in the development of the system.

The guidance, believed to be the most advanced system used by any U.S. ballistic missile, was designed, developed and assembled at the Instrumentation Laboratory in Cambridge, Mass. The lab, one of four major contractors for the Navy's Bureau of Weapons Fleet Ballistic Missile (FBM) program, is responsible for guidance system development.

Called "the most complex weapon system ever devised," one of the most difficult tasks, said an MIT spokesman, has been that of providing an inertial guidance system having guaranteed accuracy for the missiles if they are ever launched at sea against enemy targets.

Work on the application of inertial guidance began at MIT even before World War II. (First practical demonstration of the system was made in 1953 when Dr. Charles S. Draper, lab director, made a secret flight from Bedford, Mass., to Los Angeles in an aircraft navigated by the SPIRE inertial guidance system. Dr. Draper announced his accomplishment on arrival at a classified meeting on inertial guidance. This ancestor of today's light weight and compact system weighed 2800 lbs.

Similar to other systems designed at MIT for the Air Force *Titan* ICBM and *Thor* IRBM, the inertial package furnishes not only accurate but nonjammable guidance.

The General Electric plant in Pittsfield produces the inertial guidance systems in accordance with design specifications furnished by MIT.

F-1 Engine Design Goals Being Met

First year of work sees basic problems of engine design and fabrication solved as Rocketdyne completes full-scale mockup

Design goals have been met in all areas in the first year of work on the 1½-megapound-thrust F-1 engine, Rocketdyne Division of North American Aviation Inc. reports.

Tests and studies to date have confirmed solutions to the basic problems in engine design and fabrication and a full-scale mockup has been completed, Rocketdyne declared. (First photo of the mockup appeared in M/R Feb. 22, page 11).

Rocketdyne disclosed these other items of progress on the F-1 since it won the NASA development contract Dec. 17, 1958:

- Completely stable combustion has been achieved at more than 1,000,000 lbs. thrust, using a full-scale uncooled combustion chamber.
- The largest injector this side of the Iron Curtain has been tested successfully.
- Fuel and oxidizer model pump tests have verified design points chosen for the full-scale unit.
- Tests of model parts are successfully proving the design of a turbopump capable of moving fuel into the thrust chamber at a rate of three tons per second.
- Design of the gas generator has been completed.
- Construction of test facilities at Edwards AFB, Calif., is well under way after delays in certain areas caused by the steel strike.

The F-1 uses the conventional LOX-RP1 fuel combination to take full advantage of proven advanced concepts in high-thrust technology while providing maximum assurance that design goals and development schedules would be met on time, Rocketdyne said.

- **High hopes**—The F-1 is expected to be developed in about four years. NASA plans to use it in a cluster of four or six engines, providing from six to nine megapounds of thrust for a booster designed to lift very heavy payloads into space. NASA scientists envision a multistage *Nova* rocket that might tower as high as a 20-story building. The 10-year NASA space program calls for the first *Nova* flight in Fiscal 1968 and two more in 1969. The *Nova* will make it possible to put into orbit a 150,000-lb. space laboratory.

Tests to date have been conducted at Rocketdyne's Propulsion Field Laboratory in the Santa Susana Mountains near Los Angeles. Full-scale testing will be held at Edwards when facilities are complete.

The largest of three stands in the Edwards complex, designated Test Stand 1B, will rise 230 ft. over the Mojave Desert, at a cost of $12 million. The Del E. Webb Construction Co. is pouring 12,000 yards of concrete for footings, enough to pave a mile of eight-lane freeway, under the supervision of the Army Corps of Engineers. Aetron Division of Aerojet-General Corp. designed the foundation structure.

Exhaust flames from the giant engine will be directed downward and outward against a 260-ton steel deflector, protected against the heat by water flowing at 60,000 gallons a minute.

Since water is scarce in that part of the country, the water will be conducted to a small lake and conserved for future tests.

Another stand, Test Stand 2A, is almost complete on the opposite side of Luehman Ridge. Here, the F-1 thrust chambers, less their pumping mechanisms, will be fired at a 30° angle off the ridge. First testing at Edwards will take place at 2A.

Test Stand 1A, the third location, is being restructured from a stand formerly used in testing the now-operational *Atlas*. The engine will be fired 130 ft. straight downward from Stand 1A before exhaust flames reach a water-cooled deflector cradled in a rock gully.

The major contractors on Stand 2A are R. M. Parsons Co., Mid Valley Utility Constructors, Alex Robertson, Southwest Welding and Manufacturing Co. and Chicago Bridge and Iron. On Stand 1A, the main contractors are Kaiser Steel, Southwest Welding and John A. Minasian.

Fueling Satellite Proposed

PHILADELPHIA—A space "filling station" that could increase the range or payload of space missions by a factor of 10 is proposed by a Norair research scientist.

The fueling satellite—called PROFAC (Propulsive Fluid Accumulator) —was described at the AIEE Magnetohydrodynamic Symposium by Dr. Sterge T. Demetriades. Use of such a technique would cut the ratio of booster rocket weight to payload from 300:1 down to 30:1, he said.

PROFAC would be a manned air-gulping powered satellite in a 60-70 mile orbit around the earth. It would accumulate air, liquefy it and store it. Part of this air would be used to power the satellite and the remainder used to fuel outbound space vehicles.

The satellite power would be provided by a ramjet using magnetogasdynamics principles. A small part of the collected air would be used to form a jet of highly accelerated ions. The ion stream would be further accelerated and mixed with a stream of air molecules. The ions would force the air molecules out of the ramjet's exhaust nozzle at 50,000 fps, or higher, to produce thrust.

According to Dr. Demetriades, the principal problem is in the magnetogasdynamic or electrical acceleration of the air for propulsion. Technical knowledge and hardware for liquefying the air are already available, he said. The air would be accelerated by

electric or magnetic fields generated with the use of a nuclear reactor and electrical power-generating equipment.

The booster necessary to put the PROFAC satelloid into orbit would be on the order of the six-megapound *Nova*, he said. NASA has programmed the first *Nova* launching for 1967-68. The PROFAC would weigh between 76,500 and 125,000 lbs. without the liquid air.

It could collect, liquefy and store up to 500,000 lbs. of air a day from the tenuous atmosphere at that altitude, he said. Part of the air collected would serve as propellant to overcome the small drag at that altitude.

The Demetriades proposal is somewhat of an elaboration on the Project *Pluto* nuclear ramjet. In *Pluto*, air passing through the center of a nuclear reactor will provide propulsion for an aircraft. However, a *Pluto*-powered vehicle would operate at much lower altitude.

Pluto is jointly sponsored by the Air Force and the Atomic Energy Commission. Lawrence Radiation Laboratory of the University of California is working on the reactor system for the AEC. The Marquardt Corp. is doing engine design and development with Air Force funds. Atomics International, a Division of North American Aviation is studying reactor materials.

Two other companies have completed studies for the Air Force of a missile powered by a *Pluto* ramjet under Project *SLAM* (Supersonic Low Altitude Missile). They are Chance-Vought and Convair Division of General Dynamics Corp.

GE's X405H Completes Pre-Flight Rating Test

General Electric's X405H engine, which was to be the upper stage of *Vega*, has completed its pre-flight rating test.

The X405H, an advanced version of the X405 first-stage *Vanguard* engine, has been under development since last March. The *Vega* program was cancelled in December. However, since the X405H was so close to PFRT, NASA decided to complete it and have one more fully qualified engine in its inventory.

M. E. Disney of Los Angeles, West Coast flight propulsion specialist for GE's Rocket Engine Section, said the engine was operated for more than 2000 seconds in 12 consecutive static firings without component change or repair. The tests included shutdown, simulated coast periods and restarts.

The X405H, like its predecessor, uses LOX-JP propellants. Thrust was scaled from 27,850 to 35,000 lbs. Ignition was changed from single at sea level to multiple at altitude.

Vega was to have used the X405H atop an *Atlas*. The program was cancelled in favor of *Thor-Agena*, which already had developed high reliability, in view of the rapid progress of Pratt & Whitney's liquid hydrogen-LOX *Centaur* engine. The high-performance *Centaur*, also to be used atop an *Atlas*, is expected to be available within less than a year after the *Vega* would have been ready. NASA has scheduled the first *Centaur* shot for the spring of 1961.

Grand Central's *Saber* Is Better, Cheaper *Viper*

The *Saber*, a new solid-propelled rocket designed for sounding, drone boost and sled propulsion, has been introduced by the Grand Central Rocket Co.

Saber is a modernization of the GCR *Viper*, with a slightly greater performance, although the cost will be lower. *Saber* provides a total impulse of 33,000 lb.-seconds, at an average thrust level of 11,000 lbs. This compares with *Viper* impulse of 28,350 lb.-seconds at average thrust of 8100 lbs.

GCR said the *Saber* will sell for about $1000 in production quantities. *Viper* cost has been about $1500.

Saber, about 6 in. in diameter and 100 in. long, will weigh 210 lbs. It uses a nitrile propellant with some addition of aluminum, in a formulation that develops specific impulse of 230 sec. *Viper* uses polysulfide/ammonium perchlorate propellant and weighs 200 lbs.

Atlas Sustainer Reaches 481 Seconds

A 60,000-lb.-thrust *Atlas* sustainer engine was fired for 481 seconds in the Propulsion Laboratory of North American's Rocketdyne Division last month.

Rocketdyne said it was the longest firing duration ever made in the laboratory by a high-thrust rocket engine. In flight, the *Atlas* sustainer normally burns for a little over four minutes.

The sustainer is one of five engines that make up the *Atlas* powerplant, all of which are ignited at launch. The two booster engines, each with about 150,000 lbs. thrust, burn for about two minutes and then fall away. In addition to the sustainer, there are two vernier engines with 1000 lbs. thrust each.

After the sustainer burns out, the verniers supply thrust to provide fine attitude control and final thrust trim. In January, a vernier engine was burned in the laboratory for 1930 seconds.

THOR
MACE
TITAN
HAWK
ATLAS
SNARK
NIKE B
BOMARC
NIKE ZEUS
SPARROW I
SPARROW II
SPARROW III
NIKE HERCULES
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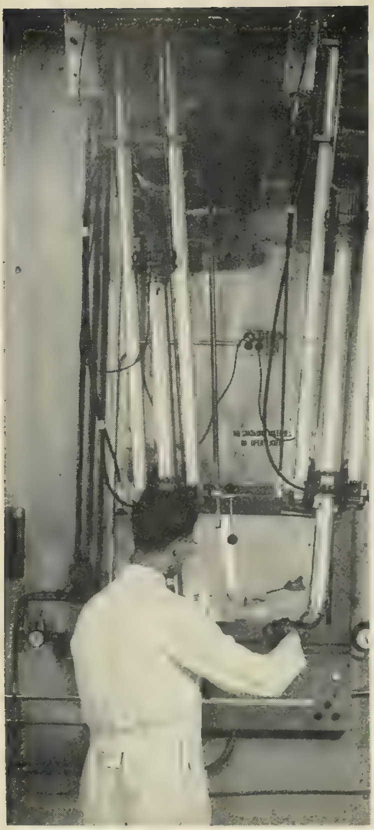


OPERATOR places dangerous chemical in beaker while standing outside chamber.

Atomic 'Slave' Used For Propellant Study

A master-slave manipulator, a device developed for handling highly radioactive materials, has been installed at a Thiokol Chemical Corp. laboratory for research in solid propellants.

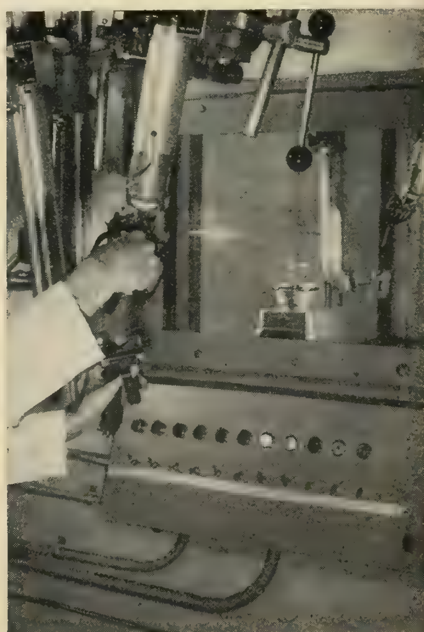
Thiokol said the manipulator, which will begin operations this month at its Elkton, Md., division, will be the first of its kind in the solid propellant industry. It serves two purposes: more rigid control of contamination of the experimental material, and safeguarding of personnel.

The "slave" duplicates all arm, wrist and pincer motions made by the operator grasping the master control outside the remotely controlled laboratory, which is protected by steel-reinforced walls 12 in. thick. A large window provides a clear view of most of the working area within the chamber. Pressure strength at the port is supplied by use of two transparent plastic sheets 1 in. thick, separated by an air gap 1 ft. wide.

The manipulators were funded by a $606,750 propellant research program granted to the Elkton Division recently by the Air Force. They were developed originally for the Argonne National Laboratory of the Atomic Energy Commission by AMF Atomics Division of American Machine and Foundry Co.

The Air Force contract calls for research aimed toward improved solid-propellant formulations for use in large rocket engines. The remotely controlled laboratory will enable an operator to remotely mix, cast, cure and radiographically test small ballistic test motors without having to expose himself or the propellant either during or between operations.

TECHNIQUE BORROWED from Atomic Energy Commission enables operator to stand safely behind transparent plastic ports.



MANIPULATOR DUPLICATES all arm, wrist and pincer motions made by remote operator.

Rover Can Be Accelerated If NASA Wants, AEC Says

Spokesmen for the Atomic Energy Commission declared last week they could develop the Project *Rover* nuclear rocket at a faster pace than demanded by requirements given the commission by the National Aeronautics and Space Administration.

The statement was made to the House Space Committee by Brig. Gen. Irving L. Branch, chief of AEC's Aircraft Reactors Branch, and his deputy, Col. Jack L. Armstrong.

Armstrong disclosed AEC plans for the firing of a *Rover* rocket 1000 miles into space by the mid-1960's. The vehicle would weigh 40,000 lbs., including a 1000-lb. payload, Armstrong said. He gave these other details:

Power would be provided by a reactor with 1000 megawatts thermal power, which would generate 52,000 lbs. thrust at liftoff and would continue in operation several minutes longer than a liquid-fueled chemical rocket.

• **Nuclear APU's**—Branch also told the committee that nuclear auxiliary power units are technically ready for use in satellites but are not being used because of fear of adverse international reaction.

Dr. Hugh Dryden, deputy NASA administrator, testified that NASA had written to the Budget Bureau supporting the AEC schedule for completion of ground testing. On the AEC proposal for firing a *Rover* rocket from the ground, Dryden said the experts in both AEC and NASA are in disagreement. He said some favored a start from orbit.

• **Off again—on again**—The Budget Bureau had stretched out the completion of the Project *Rover* ground test from 1963 to 1964. After an appeal by AEC Chairman John McCone, the commission was authorized to follow the original schedule but no additional funds were provided. The AEC was told it could shift funds to *Rover* by reprogramming.

Dryden told the committee NASA feels a sense of urgency about the nuclear rocket program. "We regret that metals and materials are so intractable," he said.

ARDC Punch Card File Will Keep Tabs on Research

Air Research & Development Command has begun the establishment of a punched-card file of all aerospace research in progress in this country, in and out of government.

The file is expected to become operational in about six months. ARDC now has such a file of all its own current technical efforts, set up for quick retrieval of information.

ARDC spokesmen said that, in addition to making it possible to keep better track of research in progress, the file is expected to pinpoint areas where more research emphasis is necessary.

Motors Checked by X-ray At Rocketdyne Facility

A 300,000-volt X-ray machine was put into operation last month at Rocketdyne's McGregor, Tex., plant to improve control over the quality of solid-propellant motors.

A 300 KV X-ray is capable of penetrating about 2 ft. of cured propellant or about 4 in. of steel. It will be used to examine propellants after they have been cast into a case and to check case weldings for internal imperfections.

Al-Mg Alloy Strength Is Boosted by Temper Process

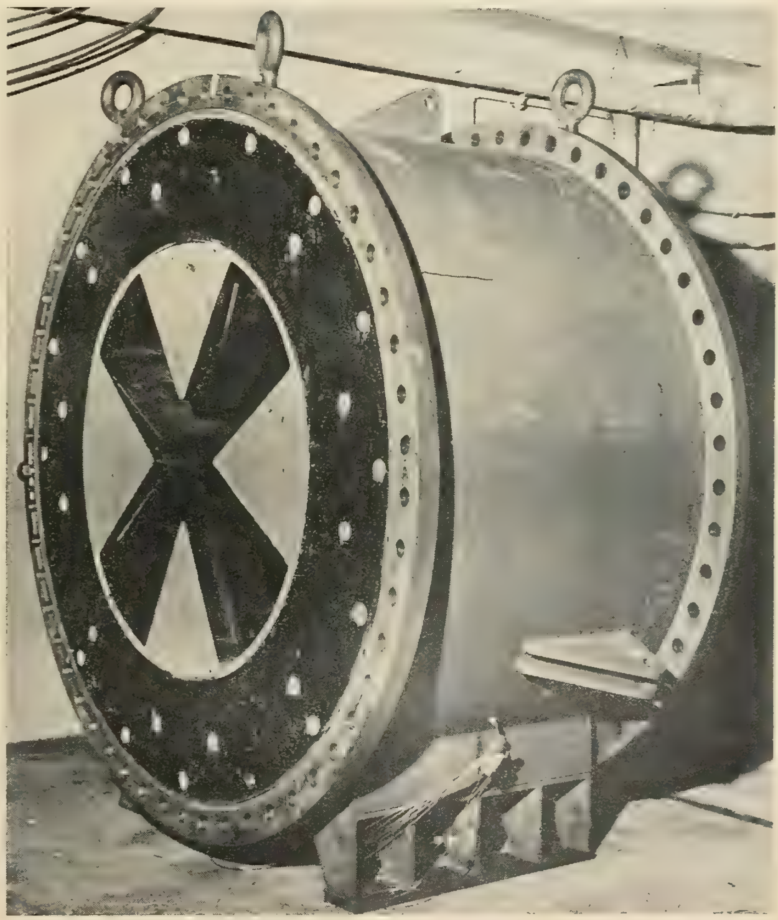
A new tempering process which increases the strength and reliability of the aluminum-magnesium alloys 5456 and 5083 has been announced by Aluminum Company of America.

The two new tempers, designated –H323 and –H343, assure a maximum resistance to stress corrosion in the sheet form. R. A. Sweet, Alcoa's sheet and plate sales manager, said that high properties were previously obtained by cold working. This increased the metal's susceptibility to stress corrosion.

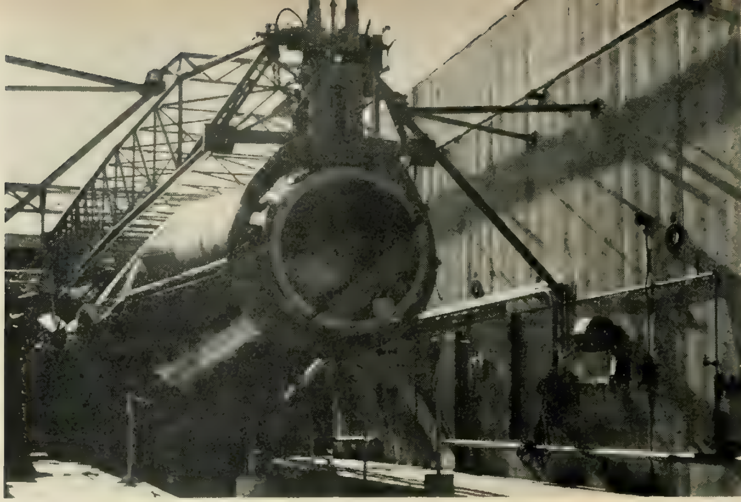
The new process gives the 5456 alloy a 4% increase in minimum tensile strength over previous methods. The sheet in these alloys has found wide use in highly stressed missile products since their introduction by

Company spokesmen did not disclose details of the tempering process.

Thiokol Casting



HUGE SLICE of solid-propellant motor, 70 in. in diameter, was cast at Redstone Division, Thiokol Chemical Corp., under study begun in 1952, proving feasibility of technique. However, Thiokol recommends on-site loading for multi-million-lb. thrust motors currently proposed.



ATLAS and erector system in "coffin" type, aboveground site. Roof is opened. Vandenberg has three such installations. The erector system is almost identical to standard Atlas transporter-erector. This and other illustrations are first photos, taken exclusively by M/R.

ground support equipment

Three More *Atlases* Near Combat Status

by **Richard Van Osten**

VANDENBERG AFB, CALIF.—Three more *Atlas* ICBM's—the first in truly combat launch pads—are about to join the nation's big missile strike force.

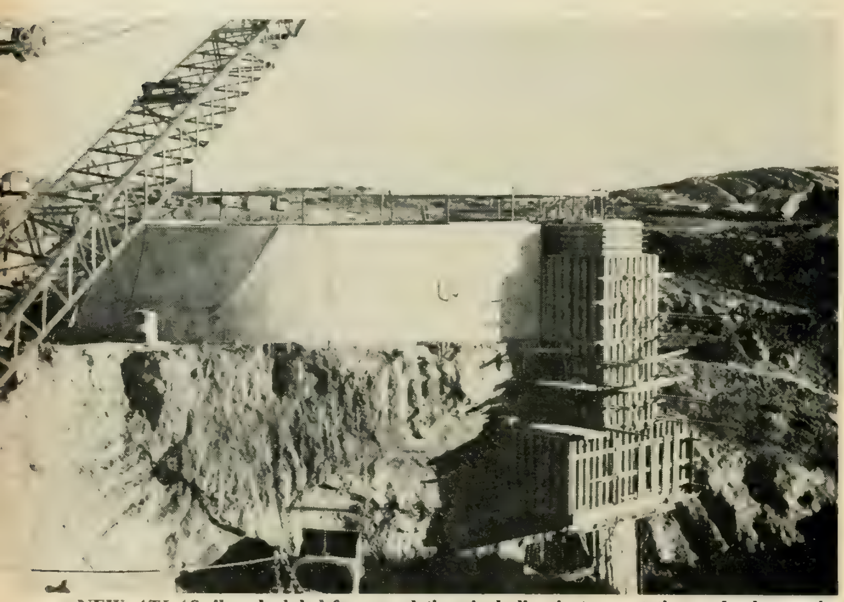
The three "coffin" type launchers now have missiles installed in their horizontal erectors and are fully instrumented. Although the Air Force has not officially designated them operational, it is believed these missiles could be pressed into service now if required. They are expected to be turned over to the Strategic Air Command in 30 to 60 days.

They bring to six the number of *Atlases* on launchers at this sprawling training and operational SAC base—the country's first. The other three *Atlases* are in R&D-type gantry pads nearby, overlooking the Pacific. They have been operational since September.

A closeup of launch facilities was given to the press for the first time recently by the 1st Missile Division. One *Atlas* was in a gantry, a second on the gantry pad, but not erected, and the third was indicated as being in full operational "hot" status. These pads are used for training as will be the second group of three above-ground "coffin" launchers.

It would appear that because of training requirements not all of the six missiles, which are capable of hurling hydrogen warheads at Russia, would be in a 15-minute alert status at the same time. At least one in each complex probably would require extra time to be fired.

Some details of how these missiles function on an operational basis were disclosed during the tour. Newsmen also were given a look at the silo-type "hard" launchers being constructed here for both *Titan* and *Atlas*—as well as other facilities being built under the base's \$200-million construction program.



NEW *ATLAS* silo scheduled for completion, including instrumentation and other equipment, by end of November. The silo is 174 ft. deep and 52 ft. in diameter. Launch Control Center (LCC) will be located 100 ft. from the silo and connected by tunnel. LCC is 40 ft. in diameter and 27 ft. high. Covered with six ft. of earth, LCC will have two floors suspended from the center post to minimize groundshock on sensitive equipment. The missile crib installation in the silo is octagonal, with wall thickness varying from six ft. at silo top to two ft. at the base.

• **Secret pouch**—Each *Atlas* launch control officer while on duty wears slung around his neck a small, sealed pouch that looks not unlike an amulet to ward off evil spirits. The contents are a closely-guarded secret. But, rather than mandrake root and a dried newt's wing, the pouch is believed to hold a

frequently changed code which enables the launch officer to verify commands for an "in-anger" shot.

Such a command would be received from SAC headquarters in Omaha over one of the two red telephone "hot lines" in the launch control center. Once it was issued, the launch officer would open the pouch and be able to verify the correctness and authenticity of the order. The Air Force says that there is one more check of "fire" command information before the key is turned for launcher power "ON" and the countdown is started.

The procedure—all part of what the Air Force calls "positive control," which is the ICBM counterpart of "fail safe" for SAC bombers—calls for verification of the "fire" order by "another command post" on the base, presumably the base commander. If still in doubt, the launch control officer could pick up his second red telephone and call 15th AF Headquarters, March AFB, Riverside, Calif.

The officer who wears the pouch is required to carry a sidearm at all times. The pouch never leaves his possession until handed over to the officer who succeeds him on duty.

• **Shock-guarding** *Atlas*—The *Atlas* silo is due for completion—including instrumentation and elevator erection equipment—by the end of November. The silo is 174 ft. deep and 52 ft. id. The launch control center (LCC) is located 100 ft. from the silo by a connecting tunnel. Covered with six feet of earth, this domed 40-ft.-diameter by 27 ft.-high structure will have two floors. Both will be suspended from a center post to minimize ground shock to sensitive equipment in the event the base is hit by an enemy nuclear warhead.

The silo's wall thickness varies from 6ft. at the top to 2 ft. at the base. The bottom is 8-ft.-thick concrete. A flame deflector will be mounted on the elevator similar to the plan for "hard" *Titan* launchers. The design is simpler than *Titan's*, however, and the smaller service silos put in the first *Titan* complex here have been eliminated. To accommodate these integral facilities, the *Atlas* missile silo has been made deeper and wider.

Launches at the *Atlas* gantry and "coffin" type horizontal pads may be held at 2½ sec., if necessary. The roof of the "coffin" launcher moves lengthwise off the missile on railed supports in something under 20 secs. to permit the missile to be raised into firing position. Automatically actuated, threaded alignment pins hold the bird in a precise pad position until launch.

For static firings, or combat launches, cooling water is eliminated. Instead, the flame deflector has an eroding or ablating concrete surface which can take the intense heat.

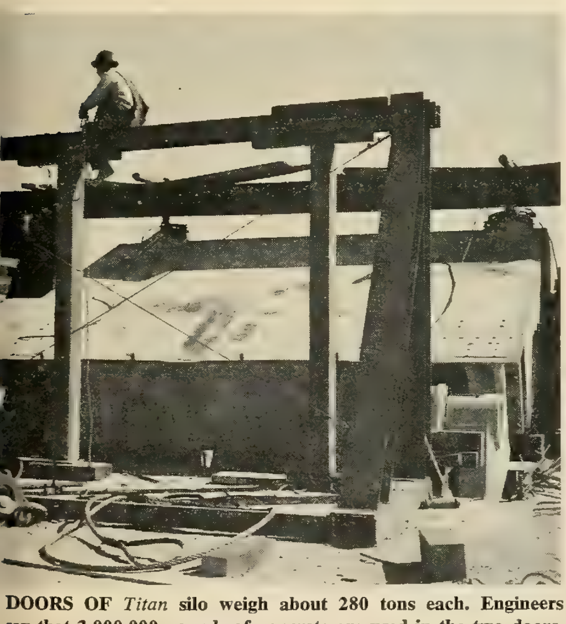
• **Four levels for** *Titan*—An extra level has been added to the *Titan* silo here for test and development operations instrumentation. Combat silos, such as those at Lowry AFB, Denver, will have four levels. The silo is about 165 ft. deep and 30 ft. id. and the launch control center is at the end of an 800-ft.-long tunnel.

Surface doors to the silo weigh about 280 tons each. Exact time for opening the huge doors and raising the missile to firing position is classified. But it is believed to be under 10 minutes.

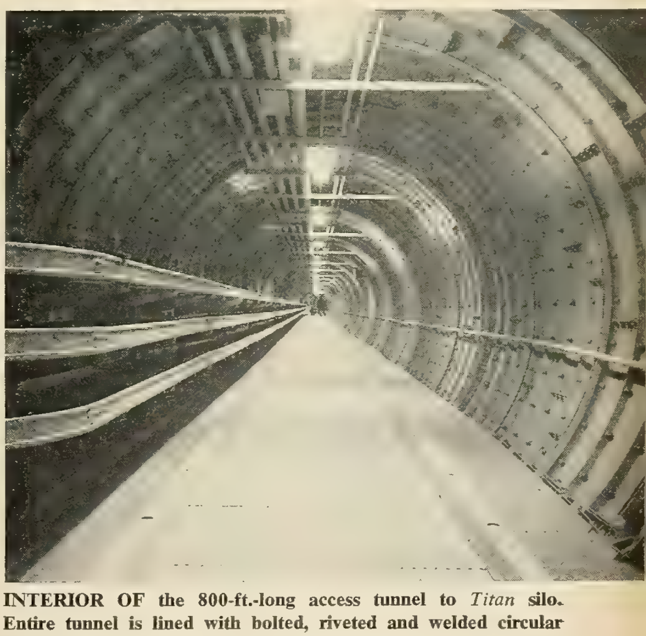
In addition to the *Atlas* and *Titan* facilities already described, two more *Atlas* pads of the "Hollywood hard" configuration are under construction. These pads, requiring the missile to be raised from a horizontal position to fire, are being built into earthen revetments to make them better able to withstand a nuclear ground shock. At combat bases, they will be built flush with the ground.

• **Gaining experience**—At the moment, construction of *Titan* and *Atlas* ICBM silos and their related facilities is being pushed at the most rapid pace possible. One reason is that final configuration of other silo-type installations will depend greatly upon Vandenberg's experience. Not all the engineering approaches have been worked out. Some "cut-and-try" approaches are still being considered, but solutions appear to be not far away.

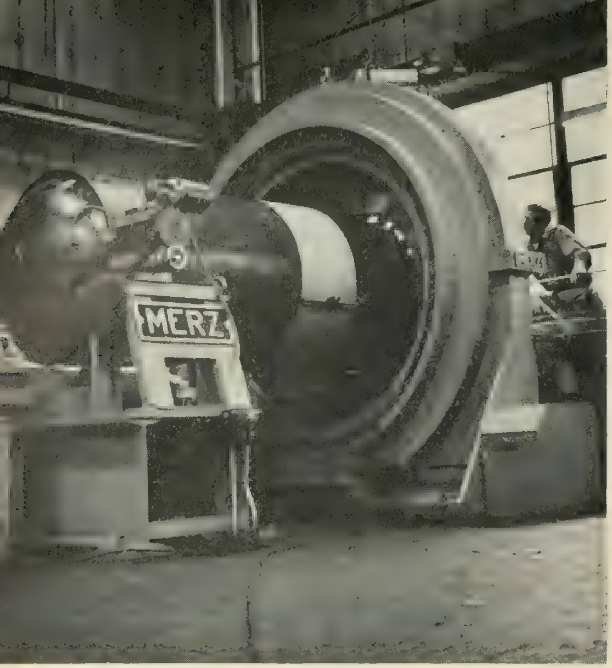
Base officials estimate (probably conservatively) that major construction may continue for at least two more years.

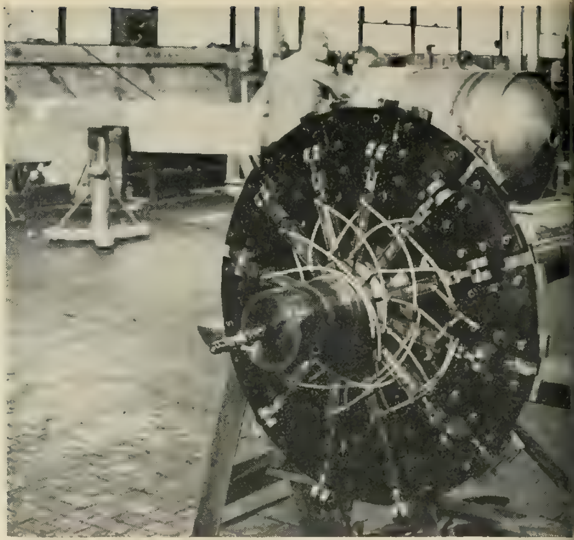


DOORS OF ***Titan*** **silo weigh about 280 tons each. Engineers say that 3,000,000 pounds of concrete are used in the two doors. The exact time needed to open the doors, lift the missile and fire it is classified, but expert estimates are that it is considerably under 10 minutes. The somewhat portly workman gives an idea of the size of the doors.**



INTERIOR OF the 800-ft.-long access tunnel to ***Titan*** **silo. Entire tunnel is lined with bolted, riveted and welded circular steel rings to guard against ground shock. The trays at the left carry instrumentation and other electrical cables to the silo from the control center. There are sub-tunnels for routing utilities to the missile.**





THREADING operation being performed on a motor case. Note the sheer bulk of the machining tool necessary to insure that the threads have the required precision.

advanced materials

Buttress Threading Cuts Case Weight

This method shows promise of higher efficiency in tackling the problem of attaching aft closure heads

One of the biggest headaches in the fabrication of large solid-rocket motor cases is in the method of attaching the aft closure heads.

Buttress threading, the latest effort to cut the weight of these fittings while maintaining high efficiency, is being developed at Merz Engineering, Inc., Indianapolis, Ind.

This type of fitting is only one of several alternative methods of attachment, but it shows the most promise. Among the other methods are breach-lock, key-lock, bolting and standard threading.

A buttress thread is normally used for unidirectional power transmission. Such a thread usually has an included angle of 45° and one face is a right helicoil. There are slight variations, but the familiar forms appear in jack-screws and gun breech locks.

The peculiar nature of motor casings necessitated development of some specially designed tooling. The ultra-high precision involved made the task even more difficult. Merz designed and built a giant thread milling maching to do the job. The machine, which is featured on the cover of this issue, can handle large cases with accuracy and precision.

• **Keeping it round**—Preserving the perfect roundess of motor cases while machining them was another major problem faced by the firm. No matter how closely production is controlled, a large case whose aft closure is unattached will inevitably relax into an oval shape. To solve this, Merz engineers came up with an expandable mandrel which slides inside the case and supports it during the threading operation. This mandrel pushes the case into perfect round through the action of hydraulic pressure on pie-shaped sectors.

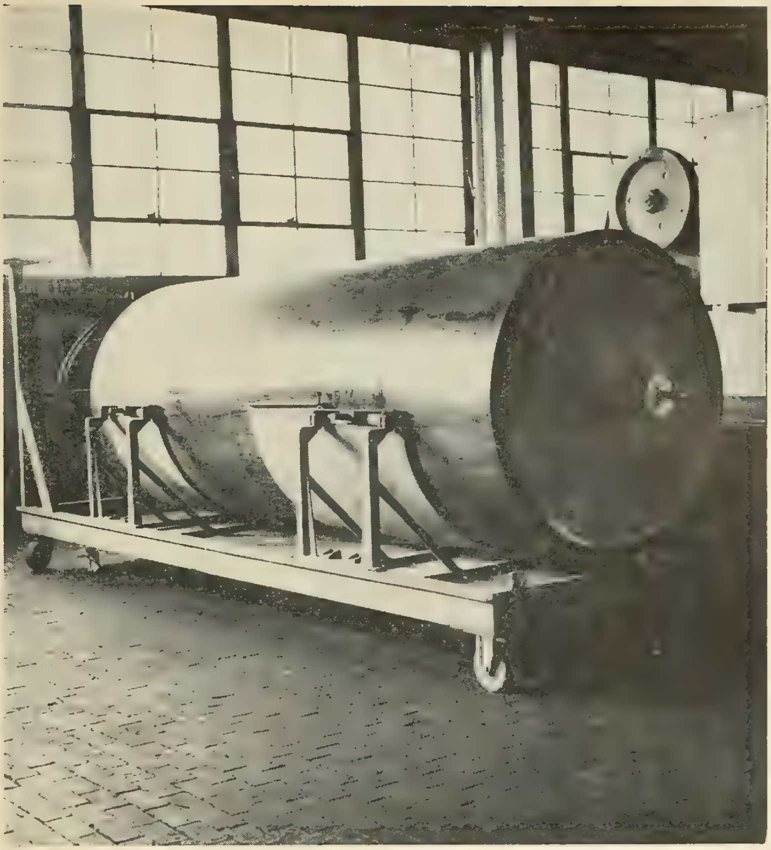
The case is first rounded up manually with an external band having 48 adjustable shoes. While this device is in place, the expandible mandrel is inserted and automatically adjusts the shape of the rounded case. Then the external band is removed.

After insertion of the mandrel and before machining, a motor case is checked optically to insure the absence of ovality.

The motor cases illustrated are of 5% chrome hot-worked die steel. The aft closure being threaded on this week's cover was machined from a single piece of metal. The present cost of three-dimensional contour milling operation is about $5000 per head. Merz has designed a milling instrument which will reduce this cost by about a third, but this device is not yet in the hardware stage.

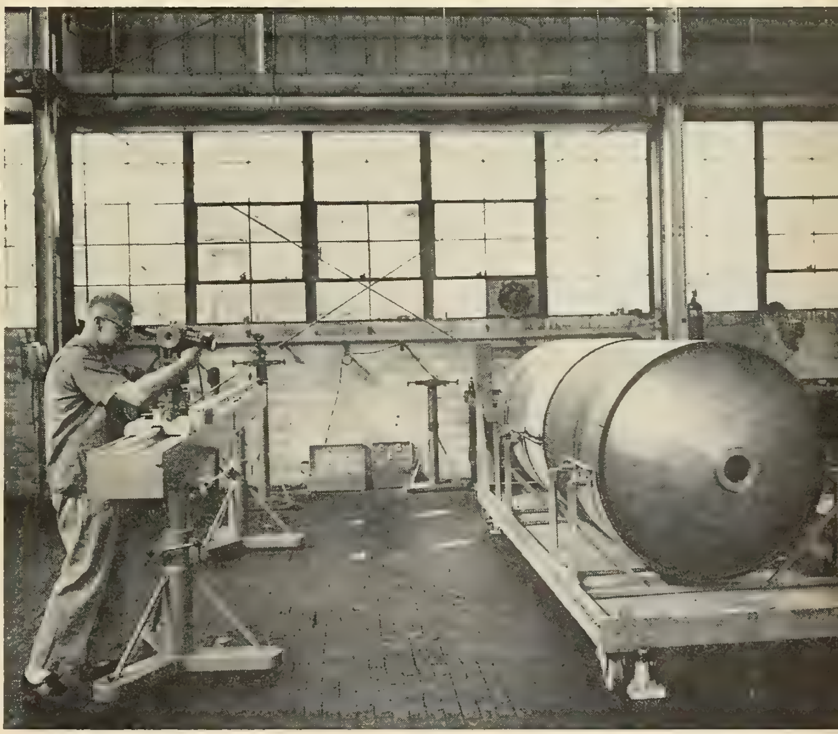
The thread milling machine is capable of handling cases up to 84 in. diameter without difficulty. The instrument may also be used to face and angle both the case and the closure head. Merz does not perform this oper-

:XPANDABLE mandrel for "rocket ounding" as it appears before being inerted into a motor case. Twelve hydrauically operated sections push the case into ı perfect round.



MANDREL is visible in the open end of this case. The special handling dolly eliminates the possibility of scratches while the workpiece is being moved from tool to tool.

OPTICAL checks are taken before machining commences to assure that the configuration of the motor case is perfect.



ation with the milling machine but company spokesmen say it can be done with relative ease.

The thread milling machine is also used for milling skirts on the motor case and making the igniter tube boss on the aft end.

An improved unit has been supplied to the Allison Division of General Motors. This machine is capable of milling even larger cases.

The idea of buttress threads in aft closures was first conceived by GE's Rocket Engine Section.

The motor case machining developments were performed under a contract with General Electric's Rocket Engine Section, Cincinnati, Ohio. Merz provided the injection head for the *Vanguard's* first-stage motor and is doing metal work on the J-93, GE's nuclear aircraft engine.

Oxygen Source

Water Electrolysis May Give Air to Astronauts

Future astronauts may breathe oxygen generated through a process known for many years—the reduction of carbon dioxide with hydrogen and the recovery of oxygen by the electrolysis of water.

John R. Foster of Battelle Memorial Institute, Columbus, O., told the 42nd National Meeting of the American Institute of Chemical Engineers in Atlanta that the process appears to be substantially superior to other methods considered.

"The apparatus has potentially a low weight, great reliability, and good efficiency with low power and energy consumption," he said.

The well known reaction has been studied extensively as a part of the technology of gas manufacture, Foster said, but the published information is not generally applicable because of the difference in objectives. The gas industry uses the process to produce fuel gas while the Battelle study involved converting gaseous carbon dioxide into solid carbon and water.

Such an oxygen-producing plant is necessary to manned space flight because of the impossibility of carrying an adequate supply of oxygen. The study was part of a project sponsored by the Air Force's Air Research and Development Command.

High-Altitude Simulator Being Built for *Mercury*

The *Mercury* capsule and its occupant will be able to dive from 225,000 feet to sea level in six seconds—yet never leave the ground.

A huge high-altitude simulator being built by Tenney Engineering, Inc. at Cape Canaveral will provide an environment comparable to that 40 miles above the earth, with dive rates, to check the functioning of the capsule.

Robert H. Brown, vice president of Tenney, said that the six-second "descent" is an emergency factor. Normal diving will be controlled from zero to 50,000 feet per minute.

The chamber will be 12 feet in diameter and 15 feet high. The capsule will be admitted through the top. An adjoining anteroom will go up to 45,000 feet and will be used for observation and as a safety entrance.

The astronaut's only link with the outside will be through an unbilical cord which will contain the oxygen feed, intercom and various control and signal lines.

Sweden Seeks Three Rocket Types

ts industry is ready to begin project—
out government funds are limited

by an M/R Correspondent

STOCKHOLM—Project *Aurora* is the ame of a proposal for Swedish space esearch rockets submitted to the wedish Space Research Council by he Swedish Astronautic Association. The proposed program, based on an xisting Swedish rocket engine, would rovide three different rockets for various altitudes.

The main elements in the *Aurora* ystem are one larger and one smaller low-burning rocket stage, and fast-urning solid-fuel rockets. By combinng these in various ways it is possible o build three rocket variants, for diferent altitudes and weights.

The three variants are called *HR-1*, *IR-2*, and *HR-3*. *HR-1* will be capable f attaining an altitude of max. 400 m (250 miles). With a payload of 25 g the altitude will be 310 km. *HR-2* an carry a useful load of 25-115 kg nd attainable altitude is 185 and 115 m respectively. *HR-3* takes between and 15 kg load to 80 and 65 km espectively; with certain modifications t can reach 100 km altitude. The ockets would be fitted with parachutes o salvage the expensive liquid-fuel ocket stages in *HR-1* and *-2* and the iseful load with the research instrunents.

The rockets are fin- and rotation-tabilized with modest acceleration alues—7.5 g for *HR-1/2* and 17 g for *IR-3*.

• Firings in 12-18 months—All important components have already been leveloped within Sweden. Depending n which alternative(s) may be chosen, he time from order to first quantity-roduced rocket would be 18-36 nonths. First firings of prototype rockets could be made after 12-18 months. From the viewpoints of cost and time, he *Aurora* project has been based on xisting Swedish rocket engines and ther equipment (developed for miliary purposes) including the *VR-3* iquid-fuel rocket developed by Svenska Flygmotor having a thrust of 6000 lbs.

• Saab is willing—Saab, according o the Society, would be natural prime contractor for the rockets. Saab's Vice President-Engineering, Lars Brising, has stated that the company is willing to support the program, if the space scientists want Swedish rockets, and to build according to order the rocket body.

Svenska Flygmotor is also very interested in the project, according to its Technical Director, G. Gudmundson. "We have parts for five *VR-3* engines and the design has been tested to complete satisfaction," he said. "Our designers have created a product which due to greater simplicity and lower weight compares well with foreign engines, for instance those used in the British *Black Knight* rocket.

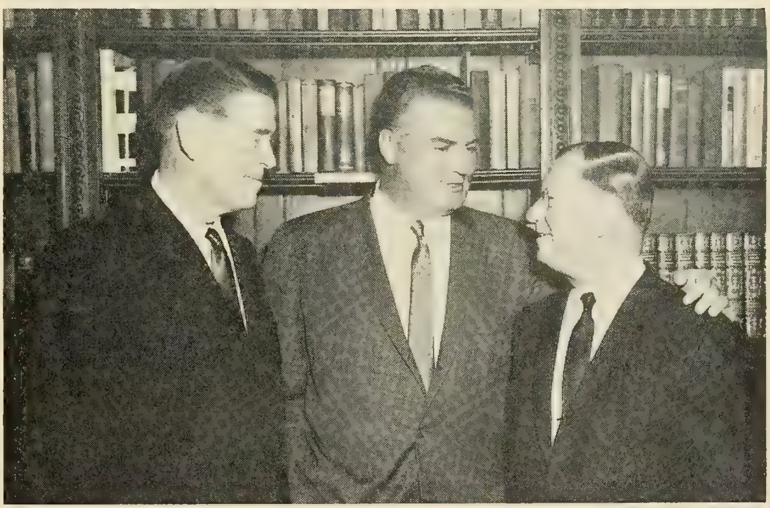
• Government uncertain—The Swedish Committee for Space Research cannot at present, however, engage itself in the *Aurora* project for economic reasons, according to its chaiman, Professor Lamek Hulthen. Our economic possibilities are very limited and a project of this size cannot be included in the budget that the research council and FOA (Armed Forces Research Establishment) can finance.

The Royal Swedish Air Board is positive to the project, but cannot yet make any official statement. Nevertheless, the men behind the project have good grounds to expect that the Air Board will provide all possible assistance within the limits of its resources, including making available instruments and ground equipments for the rockets as well as test areas.

A spokesman for the Armed Forces Research Establishment, N. Lundquist, has stated in an interview that the engineers behind the *Aurora* project have done a good job, but that they seem overly optimistic about the possibilities of carrying out the project.

If it is cheaper to buy foreign rockets than to build them at home, Lundquist urges, rockets should be purchased abroad as they will have only civil value. If the rockets are to be used for Swedish space research alone, Lundquist thinks that development cost is too high—particularly

Contribution Cited



THE FRANK M. HAWKS Memorial Award for outstanding contribution to aviation was received recently by Wayne W. Parrish, right, president and publisher of American Aviation Publications, publishers of MISSILES AND ROCKETS Magazine. Left, Earl D. Johnson, president of General Dynamics Corp., and Maj. Gen. Arno Leuhman, director of Office of Information for the Air Force.

since research work of current interest can be carried out with simpler and cheaper rockets.

Interest in Project *Aurora* is great in many quarters, but the problem is financing. To produce fifty *HR-3* rockets and twenty *HR-1* rockets would cost approximately Kr. 4,000,000 ($800,000), including development work.

Luftwaffe Begins Massive Buildup by Buying *Mace-B's*

The once-mighty Luftwaffe once again will become one of the world's strongest air forces, with the purchase of $120 million worth of U.S. Martin *Mace* missiles.

A descendant of the German V-1 pilotless bomber, the improved *Mace-B* which the Germans will receive will be atomic-tipped, with a range of 1200 nautical miles—about twice that of the "A" model currently deployed with U.S. troops in Europe.

Its warhead is considered twice as devastating as that of the *Thor* IRBM operational with the Royal Air Force. The advanced *Mace* has an inertial guidance system developed by the AC Spark Plug Division of General Motors, a development over the ATRAN (Automatic Terrain Recognition and Navigation) designed by Goodyear Aircraft Corp for *Mace A*.

Present plans for the West German Luftwaffe will make it numerically the largest air force in Europe by the mid-1960's; with acquisition of the *Mace* missile it will have a striking power second only to the U.S. Air Forces in Europe (USAFE).

NATO Will Get Missile Stock Center Now Run by AF

GENEVA—A stock center for missiles has been set up under NATO auspices at Chateauroux, France. As a result of an agreement between the U.S. Army and Air Force, the Army MAP ICP (E), (Military Assistance Program, Inventory Control Point, Europe) has been integrated into the NATO Supply Center, Provisional, as the Directorate of Army Missiles and Rockets.

The Chateauroux facility, currently managed by the USAF, will be turned over to full NATO control in mid-1961. It operates under control of the NATO Maintenance Supply Services Agency in Paris. The NATO Supply Center already stores parts for five types of aircraft used by the NATO Forces and shortly will start stocking components for the NATO lightweight fighter, the Fiat G-91.

soviet affairs . . .

By DR. ALBERT PARRY

Ocean areas as targets . . .

of trial rocket shoots, rather than land areas, will be increasingly favored by Soviet authorities. This was predicted by Professor G. Petrovsky, writing in Moscow's chief military newspaper *Krasnaya Zvezda,* on Jan. 23, in the course of a commentary on the recent successful rocket firing from somewhere in Soviet Asia to a point in the Central Pacific.

The shift from land to sea . . .

will be carried out primarily, Dr. Petrovsky says, to safeguard mankind from the "difficulties and inconveniences" which stem from explosions of rockets aimed at land regions, no matter how scarcely populated. There is less danger to man's life, limb and property if those who launch rockets take the wise measure of "setting aside for their targets such ocean areas as are situated away from the main sea routes and places of fishing, the way it was done by Soviet scientists in the latest experiment" in the Central Pacific. In the age of spaceships, oceans will become main locations of "rocket-dromes," to dispatch and receive interplanetary vessels, Dr. Petrovsky goes on. For surely "there is considerably more of sea and ocean on our planet than there is of land."

Red rocketry is going to sea in earnest . . .

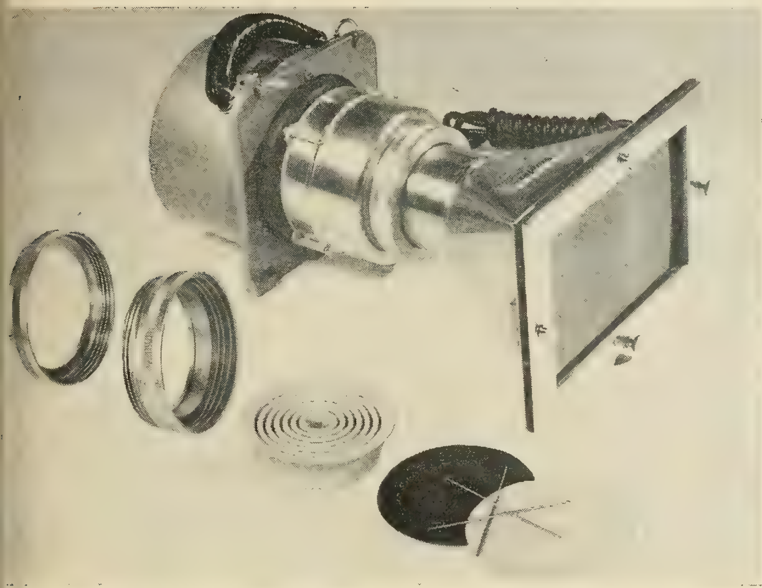
—Such is the frank implication of the statement by Professor Nicholas Varvarov, acting chairman of the Astronautic Section of the USSR's civilian defense organization (DOSAAF). In his article on "The Future of the Earth's Artificial Satellites" in *Komsomolskaya Pravda* of Feb. 2, he writes that long-term weather forecasts are now handicapped by the fact that 70% of our planet is ocean. In a few areas of the Atlantic Ocean weather observations are being made from ships, but hardly any such work is maintained in the Pacific and Indian Oceans. A number of satellites, equipped with meteorological instruments, should be sent aloft to take the needed readings of the air currents and other such phenomena in the upper atmosphere, then relay this precious information to earth-bound meteorologists. "Circling the earth in one and a half to two hours," Dr. Varvarov points out, "they will tell us about the weather over great stretches of territory." He also speaks of the importance of weather-predicting satellites as they derive and relay data while passing over the Arctic and Antarctic ice and waters.

Preliminary "casing" . . .

of the recent Central Pacific target area was done with extreme care. This was revealed in *Krasnaya Zvezda* of Jan. 22 by N. Sysoyev, acting director of the Institute of Oceanology of the Soviet Academy of Sciences. He writes that "one of the basic singularities of the area selected for rocket trials consisted of favorable meteorological conditions." He explains: "Here, in the center of the Pacific Ocean, moderate winds predominate even in winter-time, and hurricanes are rare; whereas in the northern expanse of the Pacific Ocean hurricanes roar incessantly, with winds reaching 30 to 35 miles per second."

This calm in the Central Pacific . . .

is needed, and appreciated, by the special Soviet vessels which "make the necessary soundings in the area of the rockets' fall," Sysoyev emphasizes. He adds that preliminary investigations of this Central Pacific area, southwest of Hawaii, were made by the Soviet oceanographic ship *Vitiaz* in November, 1957 (at the time of *Sputnik II*), and again in February, 1959 (soon after the firing of *Lunik I*). In the first of these expeditions the Soviet probers discovered an important underwater mountain. Sysoyev headed one of the *Vitiaz* expeditions.



Filter Expedites Air Sampling

The Staplex Company has announced that filter holder adapters ranging in size from 6" x 9" to 12" x 12" are now available for its portable, high-volume air sampler. This innovation will enable the machine to collect large samples of the air to be tested in a much shorter length of time, thus expediting the entire operation.

The air sampler is currently being used to measure air-borne particulate matter of all kinds in many diversified fields—especially those concerned with manufacture of missiles and beryllium dust. Compact and portable, the unit can measure particulate matter as small as 1/100th of a micron in diameter both indoors and out. It utilizes a turbine type blower enabling it to draw in large volumes of air in a short space of time.

The sampler is proving extremely useful in the detection and measurement of smoke and smog, air hazards in mines, occupational dusts, and factory health conditions—as well as radioactive particles.

Circle No. 225 on Subscriber Service Card.

Epoxy Molding Compounds

New epoxy molding compounds, hailed as a major breakthrough in rapid, mass production of computer and missile components, have been announced by American-Marietta Co. Adhesives, Resin & Chemical Division.

Known as EMC, the compounds are versatile plastic materials for advanced design and product development. Soft-flow molding characteristics make possible high-speed molding of a host of electronic and electrical parts from materials previously found unworkable in manufacturing processes.

EMC incorporates an outstanding balance of physical, electrical and chemical properties characteristic of epoxies in an easily handled single component system. Other major advantages include low-pressure transfer and compression molding, non-outgassing, self-extinguishing and self-releasing.

In addition, EMC has reduced manufacturing costs to as low as one-sixth of former outlays and offers a high degree of production reliability. The range of current uses runs from molding of miniature electronic parts smaller than a paper clip to the manufacture of giant electrical transformers.

Circle No. 226 on Subscriber Service Card.

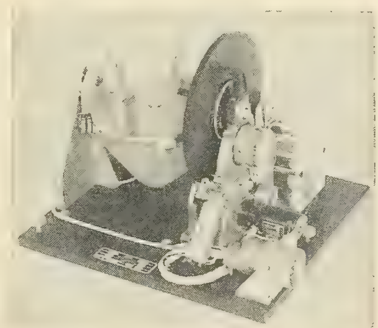
Stimuli Generators

Micro Gee Products, Inc. has announced a new series of inexpensive portable stimuli generating tables for automatic missile, drone, and aerospacecraft checkout. These tables, in conjunction with other ground support equipment, allow most any missile to be "flight tested" on the ground prior to launch by exercising the missile's gyros, accelerometers and other sensors in a precise manner as to attitude, direction and rate.

The model 18A servo table is a voltage-to-angular position platform in two axes for subjecting vertical gyros to angular positions and rate. Operation of the table about one axis tilts the load up to 90 degrees in either direction. The load may be oriented remotely through 90 degrees about a vertical axis allowing the second axis of the gyro to be subjected to the same tests as the first. A constant rate may also be commanded about the tilt axis. The table has a six-inch diameter platform, can handle a four-pound load and can be remotely controlled.

The model 82A rate table consists of a turn platform driven by a synchronous motor. The table may be remotely operated by applying or removing rated voltage. A clutch-brake, when actuated disengages the motor and engages a brake. Platform travel is controlled by limit switches. The table has a six-inch diameter platform and can handle a two-pound load.

The model 90A directional table is



a voltage-to-angular position platform for subjecting directional gyros to angular positions about a vertical axis. Operation of the table, which may be accomplished remotely, displaces it up to 180 degrees in either direction. The table has a six-inch diameter platform and can handle a four-pound load.

Circle No. 227 on Subscriber Service Card.

Electrical Silicone Fluid

An electrical grade silicone fluid combining electrical properties with a low-temperature pour point, is now available from General Electric's Sili-

cone Products Department.

Identified as SF-85 (50), the fluid is designed primarily as a dielectric fluid; however, it may be used as a special lubricant, heat transfer medium, or a mechanical fluid, in a diversity of applications.

The low-temperature pour point of SF-85 (50), below —120°F as determined by A.S.T.M. Method No. D97-47, makes it especially suitable as a dielectric in extremely low-temperature applications. The viscosity of this fluid is 50 centistokes at 25°C (77°F) and SF-85 (50) offers a smaller viscosity change at temperature extremes than conventional silicone fluids. As a result, SF-85 (50) offers application possibilities for airborne equipment subjected to both high and low temperatures.

Circle No. 228 on Subscriber Service Card.

Infrared Transmission Glass

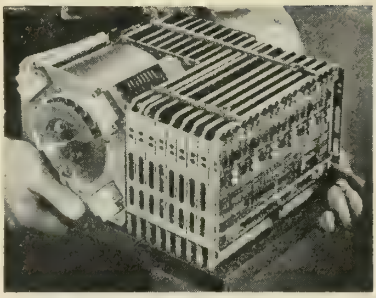
A new glass with improved infrared transmission has been developed by Corning Glass Works for high-performance IR-guided missiles and optical instruments. Dome windows of the glass make it possible for heat-seeking missiles to detect relatively low-temperature targets, according to Corning.

In a thickness of 2 mm, the glass will transmit 77% of the infrared at wavelength of 4.0 microns and 38% at wavelength of 5.5 microns. At 600°C, there is no transmission loss at 4.0 microns; only 13% loss at 5.5 microns.

Circle No. 229 on Subscriber Service Card.

Centaur Digital Computer

A miniaturized, digital computer to be integrated with the *Centaur* guidance system has been developed by Librascope, Inc., under a $1.8-million subcontract.



The Librascope computer will accept inputs from the inertial platform, perform necessary guidance computations, and provide steering signals to the *Centaur* control system. Silcon-transistorized throughout, the digital computer is immune to a wide range of environmental extremes. Weight of the computer has been reduced to 32 pounds, and it occupies only 0.55 cubic feet of precious space inside the missile.

Circle No. 230 on Subscriber Service Card.

Vacuum Electronic Pump

The Ultek Corp. has developed a Series 240 UlteVac High Vacuum Pump applicable to a broad range of uses, from vacuum-tube processing to incorporation into scientific instruments with a 40-liter per second capacity.

Operating on a cold cathode discharge within a magnetic field, the Series 240 has no moving parts and the modular internal structure is easily removed for maintenance or replacement.

Combined with an appropriate power supply, the pump constitutes a complete high-vacuum system—no traps, baffles, nor water connections are required. A roughing vacuum of 15 to 20 microns is required only for starting. After this the system can be sealed off and the Series 240 UlteVac will produce a clean ultimate vacuum below 1 x 10^{-9} mm Hg.

Compact and simple, the pump complete with magnets (as illustrated) weighs 54 lbs, has overall dimensions of 15¼ in. diam. by 7⅜ in. high. One of the mechanical advantages is the compact all-metal coupling (visible on top) having rotatable flanges. This permits any desired orientation of the pump with respect to the remainder of the vacuum system.

Circle No. 231 on Subscriber Service Card.

New Literature

TRANSFORMERS. A 36-page Stancor Transformer catalog is now available from Chicago Standard Transformer Corp. It lists over 750 transformers for industrial, communications and radio and TV applications. Among the new transformers listed for the first time, are a group of high current filament chokes and filament transformers with multiple secondaries. Over 50 transformers for transistor applications with frequency response and impedance characteristic curves are listed. In addition there are numerous other aids for the engineer and serviceman: an output transformer chart for matching output tubes to transformers; exact replacement listings of flyback transformers and yokes; illustrations and descriptions of all transformer types, as well as other helpful data.

Circle No. 200 on Subscriber Service Card.

TUNGSTEN BIBLIOGRAPHY. A complete bibliography on the element tungsten has been made available by Sylvania Electric Products Inc. It includes references appearing in U.S. and foreign publications from 1953 to 1958. Intended for research and development personnel, the book contains 44 pages with 409 references. Each reference includes the name of the author, a brief description of the article and where it appeared. In addition, it contains a subject index, a listing of physical properties of tungsten, and 19 phase diagrams. Price of the bibliography is $1.00.

Circle No. 201 on Subscriber Service Card.

PROPELLANT COMBINATIONS. Performance data for 12 possible rocket propellant combinations—each involving use of concentrated hydrogen peroxide—are set forth in a handy chart just published by Becco Chemical Division of Food Machinery and Chemical Corp. For each fuel combination, the maximum specific im-

ulse at sea level, the maximum specic impulse at sea level times the density, the maximum specific impulse in acuum, and the maximum specific npulse in vacuum times the density, ave been machine-calculated during ne past year, using the latest thermohemical data available. The 12 cominations for which data are shown re: diborane with 100% hydrogen eroxide, lithium and 99% H_2O_2, hyrogen and 100% H_2O_2, pentaborane nd 100% H_2O_2, lithium and alumium hydride with 99% H_2O_2, ethyl ecaborane and 100% H_2O_2, lithium ydride and 99% H_2O_2, aluminumnriched polyethylene and 99% H_2O_2, ydrazine and 100% H_2O_2, UDMH nd 100% H_2O_2, boron trimethyl and 9% H_2O_2, and cyanogen and 100% H_2O_2.

Circle No. 202 on Subscriber Service Card.

LECTRON MICROSCOPE. An illusrated 6-page folder, describing scienific investigations at Franklin Instiute that involve a broad variety of lectron microscope problems, is availble from Philips Electronic Instrunents. Among the subjects covered: . Study of mechanisms of plastic deormation in metals and alloys using lislocation patterns. 2. Radiation lamage in metals from neutron bomardment. 3. Strength of thin foils. 4. Perfection of evaporated films.

Circle No. 203 on Subscriber Service Card.

STOCK CATALOG. The very latest prices, listings and data are carried in a new issue of Ohmite Manufacturing Company's 32-page, two-color Stock Catalog No. 30A. This is the biggest catalog to date of those items stocked by Ohmite and its distributors for immediate delivery. It lists an increased selection of Ohmite's long-established products as well as some of its newer units.

Circle No. 204 on Subscriber Service Card.

HYDROCARBON DETECTOR. A brochure describing the new Model 213 Hydrocarbon Detector, a completely self-contained portable instrument for rapid measurement of total organically bonded carbons in atmosphere or gases, has been published by the Instrument Division, Perkin-Elmer Corporation. The Hydrocarbon Detector is based upon the flame ionization detector recently developed for gas chromatography. It simply and accurately detects and measures fractions of parts per million of such organic carbon compounds as hydrocarbons, aldehydes, ketones, alcohols, and amines with a sensitivity range adjustable from as low as 0-1 ppm full scale to 10% full scale.

Circle No. 205 on Subscriber Service Card.

WHO READS MISSILES AND ROCKETS?

Well, for instance...TOP ENGINEERS OF LOCKHEED

Lockheed has been in the space business for more than forty years exploring, applying, and extending the science of flight almost since its birth. Today the company faces a new frontier — flight in the cosmos beyond the earth's atmosphere. Formed in 1954, Lockheed Missiles and Space Division now employs more than 20,000 people including international specialists in every field of physical science. Its ten facilities comprise 2.5 million square feet of floor space and nearly 5000 acres of land devoted to research, development, manufacturing, and flight testing.

Space travel, whether the vehicle be manned or unmanned, poses vast challenges. Lockheed Missiles and Space Division's approach has been a penetrating and intensive one. In propulsion, guidance, communication, structures, and system management, Lockheed is helping to advance the state of the arts and technologies so vital to free world defense.

Lockheed Missiles and Space Division achievements include some of the most technically advanced products of the space age. Among them are the Polaris ballistic missile, the Agena satellite, the X-17 solid propellant rocket and the Kingfisher target missile. Lockheed's missile and space ac-

—contracts—

NAVY

$25,200,000—**Convair, Astronautics Division, General Dynamics Corp.**, Pomona, Calif., for additional production of advanced *Terrier* guided missiles.

$5,914,000—**Ryan Electronics, Division of Ryan Aeronautical Co.**, San Diego, for procurement of AN/APN-130 Doppler radar navigation sets, spares, support equipment and engineering support items.

$5,000,000—**Collins Radio Co.**, Cedar Rapids, Iowa, for supplying BuShips with additional URC-32 single sideband transceivers.

$4,300,000—**Raytheon Co.**, for extending the range and high-altitude capabilities of the *Sparrow III*.

$2,000,000—**Thiokol Chemical Corp.**, Denville, N.J., for development of a prepackaged liquid rocket engine.

$119,771—**Houdaille Industries Inc., Buffalo Hydraulics Division**, Buffalo, for damper assembly, missile tray.

NASA

Amount undisclosed—**Stromberg-Carlson**, San Diego, for design, construction and installation of the vital monitor and control display system for Project *Mercury*.

$33,500,000—**McDonnell Aircraft Corp.**, for increasing the number of capsules for Project *Mercury* to 20.

$19,000,000—Air Research and Development Command, initial NASA funding of a $43-million contract with **Convair** for airframe, stage integration and upper storage tanks of *Centaur*. ARDC is supplying technical support.

$252,000—**Electronic Associates, Inc.**, Long Branch, N.J., for analog computer system to be used in data reduction work in the *X-15* research plane.

$165,000—**Trans-Sonics, Inc.**, Burlington, Mass., for propellant loading system for *Centaur*. (Subcontract from **Convair Astronautics**.)

$29,320—**Heintz Div., Kelsey-Hayes Co.**, Philadelphia, for fabrication, machining and assembly of 10 rocket engines.

AIR FORCE

$9,500,000—**Electronic Communications, Inc.**, (a subcontract from **Burroughs Corp.** for work on ALBI defense program).

$7,000,000—**Sylvania Electric Products, Inc.**, Mountain View, Calif., for development and production of a ground countermeasures receiving system.

$1,600,000—**Boeing Airplane Co.**, Wichita, Kan., for engineering studies, wind tunnel tests and flight test planning for the *Skybolt*.

$146,079—**Milgo Electronic Corp.**, Miami, for radar impact prediction system.

$119,781—**Oklahoma State University**, Stillwater, for research and development of instrumentation for research rockets.

$75,000—**University of Utah**, Salt Lake City, for research and development of circuitry for measurement of upper atmospheric density from rockets.

$59,775—**University of Colorado**, for research and development leading to fabrication, assembly and testing of biaxial pointing controls and associated telemetry problems.

$57,600—**United States Rubber Co.**, Wayne, N.J., for research of nuclear chemistry of short-lived isotopes.

$45,000—**Georgetown University**, Washington, D.C., for research directed toward refinements of geodetic measurement techniques, utilizing terrestrial and spatial configurations.

$38,315—**Coleman Engineering Co.**, Torrance, Calif., for guidance test sled.

$31,470—**Ampex Data Products Co.**, Los Angeles, for recorder for use in support of project *WS-133A*.

$30,164—**Arizona State University**, Tempe, for research on electrical conduction in oxides of some lanthanide rare earth elements.

North Electric Co., Galion, Ohio, for design and manufacture of mobile and fixed electronic communications and switching centers. Subcontract from **General Electric Co.**, amount not disclosed.

ARMY

$20,259,484—**Western Electric Co.**, for improvements on *Nike-Hercules* system.

$12,687,000—**The Martin Co.**, Orlando, for continued production, engineering services and ground support equipment for *Lacrosse*. (Two contracts.)

$10,888,178—**Paul Hardemann, Inc.**, Stanton, Calif., for propellant loading systems to be installed at ballistic missile test and operational facilities.

$9,200,000—**Chrysler Corp.**, for continued work on *Jupiter*.

$5,333,673—**Sperry Utah Engineering Laboratory**, for continued R&D on *Sergeant*.

$2,377,848—**Raytheon Co.**, Waltham, Mass., for work on the *Hawk* missile.

$2,024,279—**Minneapolis-Honeywell Regulator Co.**, Hopkins, Minn. (classified R&D).

$993,393—**Southern, Waldrip and Harvick Co.**, Long Beach, Calif. for construction and installation of fuel storage facilities and a propellant loading system for fueling *Atlas*-boosted space vehicles.

$954,772—**Douglas Aircraft Co., Inc.**, for *Nike-Hercules* missile launching area and adaption kits.

$944,360—**Sperry Utah Engineering Laboratory**, for *Sergeant* missile repair parts and test equipment.

$443,266—**Aerojet-General Corp.**, for research and development.

$300,324—**Hayes Aircraft Co.**, Birmingham, Ala., for work on ground support equipment for *Saturn*.

$236,418—**Cooper Development Corp.**, Monrovia, Calif., for models of passive target high-altitude wind sensing equipment and related items.

$200,000—**Philco Corp.**, Philadelphia, for work on *Courier* communications satellite.

$121,169—**Ets-Hokin and Galvan**, Wilmington, Calif., for off-site utilities for silo launch complex.

$99,485—**Raytheon Co., Waltham, Mass.**, for replenishment repair parts for *Hawk* missile system.

$81,502—**A. J. Diani Construction Co., Inc.**, Santa Maria, Calif., for off-site utilities for silo launch complex at Vandenberg AFB.

$53,646—**Texas Instrument Co.**, Dallas, for subcarrier oscillator assembly.

$45,740—**Western Electric Co.**, for *Nike* spare parts and components.

$27,375—**W. M. Lyles Co.**, Avenal, Calif., for off-site utilities for launch site complex at Vandenberg.

$6,937,000—**Raytheon Co.**, Waltham, Mass., for work on the *Hawk* missile.

$64,465—**Consolidated Electronics Corp.**, Pasadena, for three oscillographs and one recorder oscillograph.

Southwestern Industrial Electronics Co., Division of Dresser Industries, Inc., Houston, for 240 signal conditioning modules for use on the *Pershing* missile. Subcontract from **The Martin Co.**, amount not disclosed.

MISCELLANEOUS

$60,000—**Electronic Engineering Co. of California**, Santa Ana, for design and construction of data translation equipment.

—reviews—

FEDERAL PATENT POLICY, Key issues in current government studies of patent rights under government contracts, Machinery and Allied Products Institute, and Council for Technological Advancement, 1200 18th St. N.W., Washington 6, D.C. 112 pp. $1.50.

The pamphlet consists of three Institute statements addressed to the public congressional hearings inquiring into government procurement patent policy. The present patent problem is outlined, its critical character explained and the nature of the present intragovernment dispute over procurement patent policy treated.

The lines of direct attack being made upon the whole of the existing patent system are identified. The book presents the position of the Institute in regard to these questions but does not make any suggestions as to a course of action. The author's intention is to illuminate the issues involved.

MATERIALS AND TECHNIQUES FOR ELECTRON TUBES. Walter H. Kohl. Reinhold Publishing Corp., New York. 638 pp. $16.50.

This book covers in detail the composition, properties, and behavior of the materials used in vacuum tubes and the techniques for their assembly. It completely revises the author's previous work on the subject (Materials Technology for Electron Tubes), and includes all advances since that time.

The text is written and organized on the basis of replies to a questionnaire sent to users of the previous volume. It covers all the material components of electron tubes and the methods of uniting them—brazing, glass-to-metal sealing, and ceramic-to-metal sealing. Chapters dealing with specific materials contain extensive tabulations of physical characteristics, chemical reactions with various reagents, and processes used in application.

THE AEROSPACE YEAR BOOK (Formerly Aircraft Year Book) Forty-First Annual Edition. Official publication of the Aerospace Industries Association, Inc. Published by American Aviation Publications, Inc., Washington 5, D.C. 478 pp. $10.

This profusely illustrated volume is the standard reference on United States aircraft, missiles and spacecraft.

It includes a complete pictorial review of the outstanding aerospace events of 1959; photographs, specifications, and three-view drawings of aircraft and engines in production, and photographs and status reports on all missiles in operation, production and development.

A summary of the aerospace industry and airline operations during the year and a survey of aviation activities in the Department of Defense, Air Force, Army, Navy, and other government departments and agencies are included.

The Year Book also has a digest of aircraft and missile research and development progress, a chronology of American aviation history and a listing of official records established in the U.S. during 1959.

names in the news

Dr. William B. Tarpley: Former director of chemical research and development, elected vice president, Chemical Division of Aeroprojects Inc. Prior to joining the firm was chief of applied research, Army Chemical Corps, at Fort Detrick and manager of research, Schering Corp.


TARPLEY

Joseph B. Rice, Jr.: Former director of manufacturing, ElectroData Division, named general manager of Burroughs Corp.'s new ElectroData Manufacturing and Engineering Division.

Nelson C. White, Jr.: Appointed manager of product information for General Electric's Rocket Engine Section. Previously served as a specialist in programing, contracts and marketing research.

Jerome J. Ginsburg: Elected vice president-finance and a member of the board of directors at Tempo Instrument, Inc. Was formerly a partner in the firm of Rosen, Resnick & Ginsburg.

Robert C. Clark: Former buyer for Pratt & Whitney Aircraft Division of United Aircraft Corp., joins Taylor Fibre Co., as a sales engineer in the New England district sales office at Hartford, Conn.

Dr. John J. Bordeaux: Research scientist in electrochemistry and physical chemistry, joins Rheem Semiconductor Corp. as a member of the research and development team.

Previous posts. Senior research scientist in the electrochemistry and solid-state chemistry section of the missile and space division of Lockheed Aircraft Corp.; group leader of researchers studying corrosion for the atomic energy division of Phillips Petroleum Co. and research chemist in the department of metallurgical research, Kaiser Aluminum and Chemical Corp.


BORDEAUX

William F. Hafstrom: Named director of marketing for Autonetics, a division of North America Aviation, Inc., succeeding **Charles A. Wolf,** now operations manager of the division's new Armament and Flight Control product division.

Previous posts: Assistant to the vice president, Bendix Aviation Corp.; marketing manager, electronics division, Stromberg-Carlson Corp.

Frank R. Wallace, Jr.: Formerly manager of materials for Tele-Dynamics, Inc., elected manager-manufacturing at Rese Engineering, Inc.

William T. Caldwell: Former sales manager for Rheem Manufacturing Co.'s Electronics Division, appointed assistant vice president and marketing manager of the contracts administration department of Amelco, Inc.

James E. Glauser: Named director-engineering of Pacific Scientific Co.'s Anaheim facility. Has served the firm's Aero Division in various engineering capacities for more than 15 years.

Ralph R. Stubbe: Appointed engineering manager of C. A. Rypinski Co. Formerly held engineering posts with Standard Coil Products Co., Inc.; Westinghouse, Hazeltine and General Instrument Co., Inc.

Allan Easton: Executive staff member of General Transistor Corp., elected to the board of directors of Efcon, Inc., replacing **Norman Neumann,** recently elected president of General Transistor Corp.

Previous posts: vice president-marketing, General Transistor; vice president and general manager, Granco Products, Inc.; chief engineer, Radio Receptor Corp. and Teletone Radio Corp.


EASTON

Jack G. Anderson: Formerly Hoffman Electronics Corp.'s vice president-marketing, elected vice president-government relations at Stromberg-Carlson division of General Dynamics Corp.

Oscar F. Carlson: Former assistant to the chairman-president of Douglas Aircraft Co., named assistant to the general manager of the Martin Co.'s Denver Division, concerned with overall management and administration of the *Titan* weapon system.

Dr. William L. Whitson: Former vice president-engineering at Daystrom Inc., joins The Martin Co.'s Denver Division as director of advanced programs.

Previous posts: Acting chief scientist at ARPA and assistant director at the Institute for Defense Analyses in Washington, D.C.

Col. Edward N. Hall (USAF, ret.): Appointed assistant to **Perry W. Pratt,** vice president and chief scientist at United Aircraft Corp. Was formerly director of the large rocket development program at the Air Force Western Development division, working on the *Thor* and *Minuteman.*

William C. House: Returns to Aerojet-General Corp. as director-systems management to coordinate the work of the Systems and Space Technology Divisions. Was on a one-year leave-of-absence with ARPA. Formerly directed the Systems Division which developed and produces the second-stage *Able* rocket.

James H. Rowell: Promoted to assistant chief engineer at Phillips Control Corp. Prior to joining the firm was applications engineer with Electric Service Engineering Co.

Barney D. Chouinard: Former engineer-designer at Douglas Aircraft Co., joins Precision Instrument Co. as customer service manager.

Dr. A. Charlesby: Appointed senior scientific advisor to Radiation Applications, Inc. Is currently professor of physics at The Royal Military College of Science, Shrivenham, England, and serves as a consultant to the United Kingdom Atomic Energy Authority.

Sydney Shrage and **Andrew J. Kubica:** Join the staff of Power Systems Product Development, Tapco Group, Thompson Ramo Wooldridge, Inc.

Shrage, named senior project engineer, was formerly a member of the corporate engineering staff at Martin-Baltimore, where he was responsible for space vehicle power systems, including the secondary power system in the *Dyna-Soar* program.


SHRAGE

Kubica, who will serve as an engineering specialist, formerly headed the preliminary design group, Special Project Laboratories, Food Machinery & Chemical Corp. He developed reaction control systems for Project *Mercury.*


KUBICA

Dr. Kenneth W. Gardiner: Formerly assistant research chemist, elected chief of Consolidated Electrodynamics Corp., subsidiary of Bell & Howell Co.

Previous posts: Director, General Chemistry Laboratory, Central Research Division, Continental Can Co.; owner and director of Gardiner Instrument Research Laboratory.

when and where

MARCH

ASME Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, March 6-9.

Society of Instrument Technology, "Data Reduction for Guided Weapon Trials at Aberporth," Manson House, London, March 7.

Heat Transfer Symposium, Mechanical Engineering Dept., University of Florida, Gainesville, March 7-8.

Society for Aircraft Material and Process Engineers, Midwest Chapter Symposium, "Processing Materials for Re-Entry Structures," Miami Hotel, Dayton, Ohio, March 9-10.

Mechanical Properties of Engineering Ceramics, North Carolina State College School of Engineering and Office of Ordnance Research, U.S. Army, N.C. State College Campus, Raleigh, March 9-11.

Institute of the Aeronautical Sciences, National Flight Propulsion Meeting, classified, Cleveland, Ohio, March 10-11.

Electronics Industries Association, Defense Planning Seminar, Statler-Hilton Hotel, Washington, D.C., March 15.

Institute of Radio Electronics, 1960 International Convention, Waldorf-Astoria Hotel and New York Coliseum, New York City, March 21-24.

Ground Support Equipment Conference, American Rocket Society, Statler-Hilton Hotel, Detroit, March 23-25.

Symposium on Optical Spectrometric Measurement of High Temperatures, sponsored by University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation, University of Chicago, March 23-25.

22nd Annual American Power Conference, sponsored by Illinois Institute of Technology, American Society of Mechanical Engineering and others, Sherman Hotel, Chicago, March 29-31.

APRIL

University of Connecticut, Sixth Annual Advanced Statistical Quality Control Institute, Storrs, April 3-15.

Solar Energy Symposium, American Society of Mechnical Engineers and Mechanical Engineering Dept., University of Florida, Gainesville, April 4-5.

1960 Nuclear Congress, "What will the future development of nuclear energy demand from engineers?" sponsored by 28 engineering, scientific, management and technical organizations. Includes 6th Nuclear Engineering and Science Conference, 8th NICB Atomic Energy in Industry Conference, 6th International Atomic Exposition, New York City Coliseum, April 4-7.

American Chemical Society, 137th National Meeting, Cleveland, April 5-14.

American Rocket Society, Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif., April 6-8.

1960 National Meeting, "Hyper-environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, April 6-8.

Royal Aeronautical Society, Coventry Branch, "The Optimum Size of Rocket Engines," Coventry, England, April 7.

Society of Instrument Technology, "The Electronic Computer as a Unit in an Automatic Data-Processing System for Missile Trials," Overheu, London, April 7.

ASME-SAM Management Engineering Conference, Statler-Hilton Hotel, New York City, April 7-8.

Advertiser's Index

CLASSIFIED

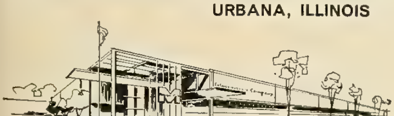
at magnavox there's no getting lost in the crowd. As an engineer in our government and industrial divisions, you stand out as an individual with ideas. Ideas that we listen to. Ideas that are put into motion. Ideas that step you ahead . . . fast.

But while we gladly admit to NOT being a giant, neither do we take a back seat to anyone in the kind of creative climate we offer engineers. We are, in fact, currently engaged in a vast number of highly specialized areas of electronic activity and our customers rank among the principal names in business and government both here and abroad.

At present, we need engineers to carry on expanding programs in communications, airborne radar, missiles, anti-submarine warfare systems and data processing equipment. The projects we have on tap are broad and challenging. The men we offer as your associates are high caliber creative scientists like yourself. And the technical facilities we provide are the finest, most complete anywhere.

FORT WAYNE, INDIANA

URBANA, ILLINOIS



LOS ANGELES, CALIFORNIA

If you're a man who likes to accept challenge—and wants to be recognized for it—we'd be glad to hear from you. Phone Dick Eary (collect, of course) at Eastbrook 9721 in Fort Wayne or write him today for complete information.

Magnavox

THE MAGNAVOX CO. • DEPT. 239 • *Government and Industrial Division* **• FORT WAYNE, IND.**

Circle No. 12 on Subscriber Service Card.

Let's Be Daring But Not Ridiculous

In these dawning days of the Space Age there is a great need for soaring, unfettered imagination, for daring in vision and boldness in thinking, for enthusiasm.

But enthusiasm and daring alone are not enough. They must be tempered by discriminating judgment as to what is practical, what is possible—and what is idiotic.

One observer has cynically noted that enthusiasm for "blue-sky" research is inversely proportional to knowledge of the problems involved —and directly proportional to the amount of government contract money available.

An executive of a great U.S. missile manufacturer has this framed admonition on the wall of his office:

"The technical axiom that nothing is impossible sinisterly conditions one to the pitfall corollary that nothing is ridiculous."

There is little question that many dollars have been spent on far-fetched ideas that have no basis in practicality or even in possibility. By the same token, contractor management has often sold gold-plated R & D projects to the military knowing them to be without merit and certainly unworthy of their own company-supported financing. To many, the government appears as a benevolent grandfather bestowing largesse on a favored few.

Complicating the problem is the fact that many in the military are not really competent to judge the merit of these rosy promises hard-sold by reputable companies. This is no reflection on the abilities of the buyer. He just cannot be as technically up-to-date as the men who have researched pet ideas in laboratories for years. Somewhere along the line, the buyer must accept the word of a man who should know.

A further complication is that in our mad pursuit of progress we're afraid of overlooking a good bet. Whether it's a death ray, control of the weather, changing the earth's magetic field, or nullifying gravity—hope for a solution to our problems of defense and maintenance of the peace often leads to indiscriminate spending of money on elusive and impractical goals.

This is not to say that blue-sky research should be stopped. What appears "far-out" today may be possible—and urgently necessary—tomorrow. Worthwhile ideas must be explored if we are to survive.

The problem places a burden on both the military and industry. Our defense program must have realistic goals and lines of progress. Any proposed projects outside the accepted guide lines should be viewed with fine discrimination. Decisions must be based on technical judgment and logical extrapolations—not wishful thinking.

The greater burden falls on industry. Not only technical judgment, but moral obligation must be considered in determining the merit of a project. The decisive factor should be whether the manufacturer thinks an idea merits investment of his own money—with a fair chance of profitable return. Industry must be objective and unselfish.

Clarke Newlon

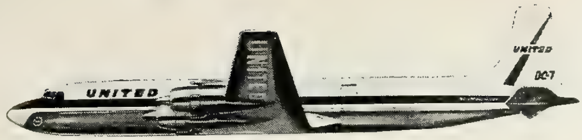
Paradoxes of Power

The American tourist in Russia who cried out in the lobby of the Hotel Ukrainia, "These people can't even get me a ticket to Odessa! How can anyone suppose that they could send a rocket to the moon?" misconstrues the situation. He innocently supposes that service to the consumer is the ultimate test of economic and administrative efficiency. Khrushchev operates under no such illusion.

The Soviet leadership thinks it important to send a rocket to the moon and not very important to supply tourists with tickets to Odessa, so they apportion their talent and resources accordingly. The able men work on rockets, the dopes on tickets.

Our own beloved country meanders along on the opposite theory: we allow the market to determine our national priorities, which means that we allocate a major share of our talent and resources to consumer services and too often leave the sending of rockets to the moon to men who might be better employed selling tickets to Odessa.

Reprinted from Encounter Magazine—*Arthur Schlesinger, Jr.*



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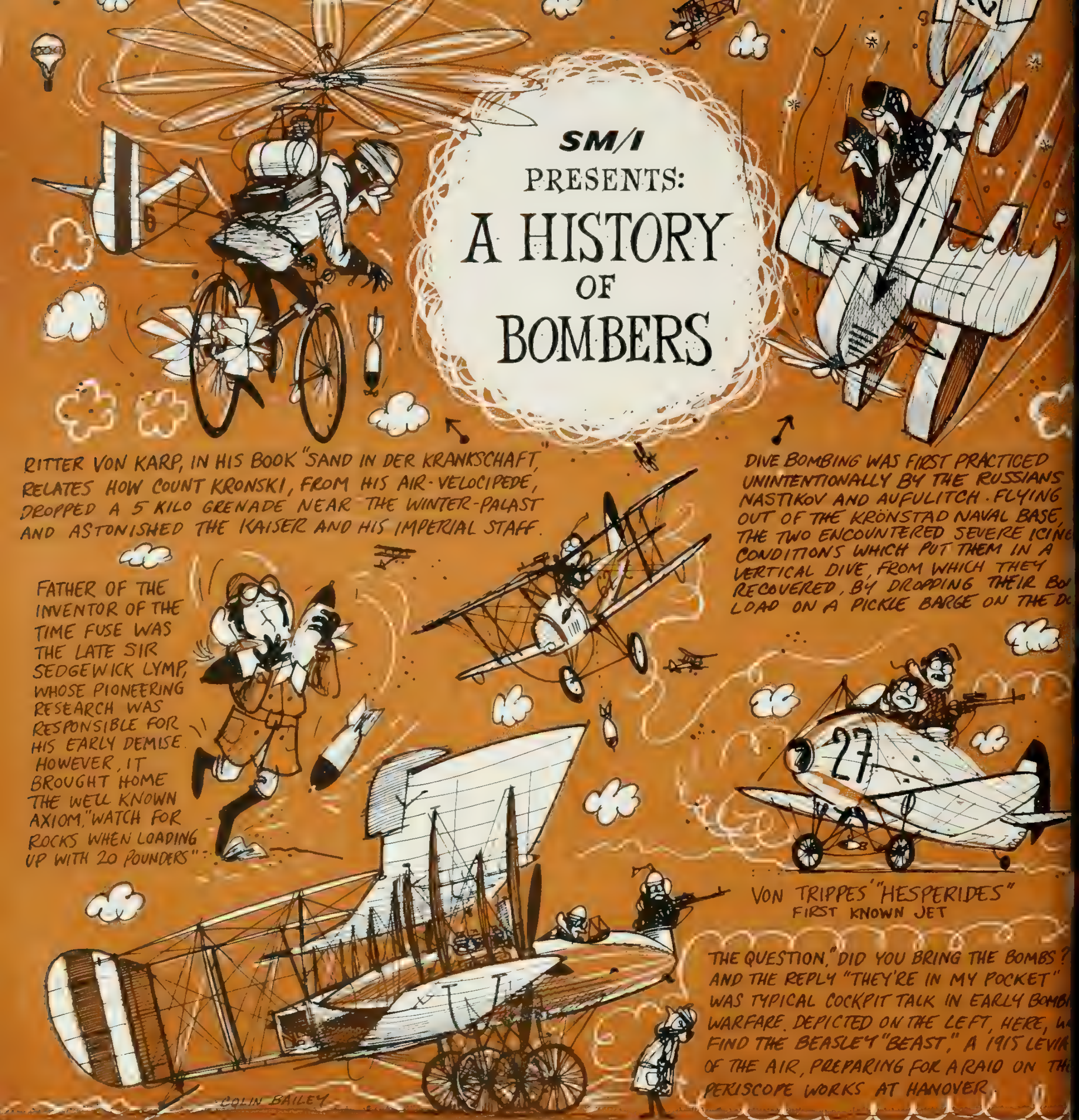

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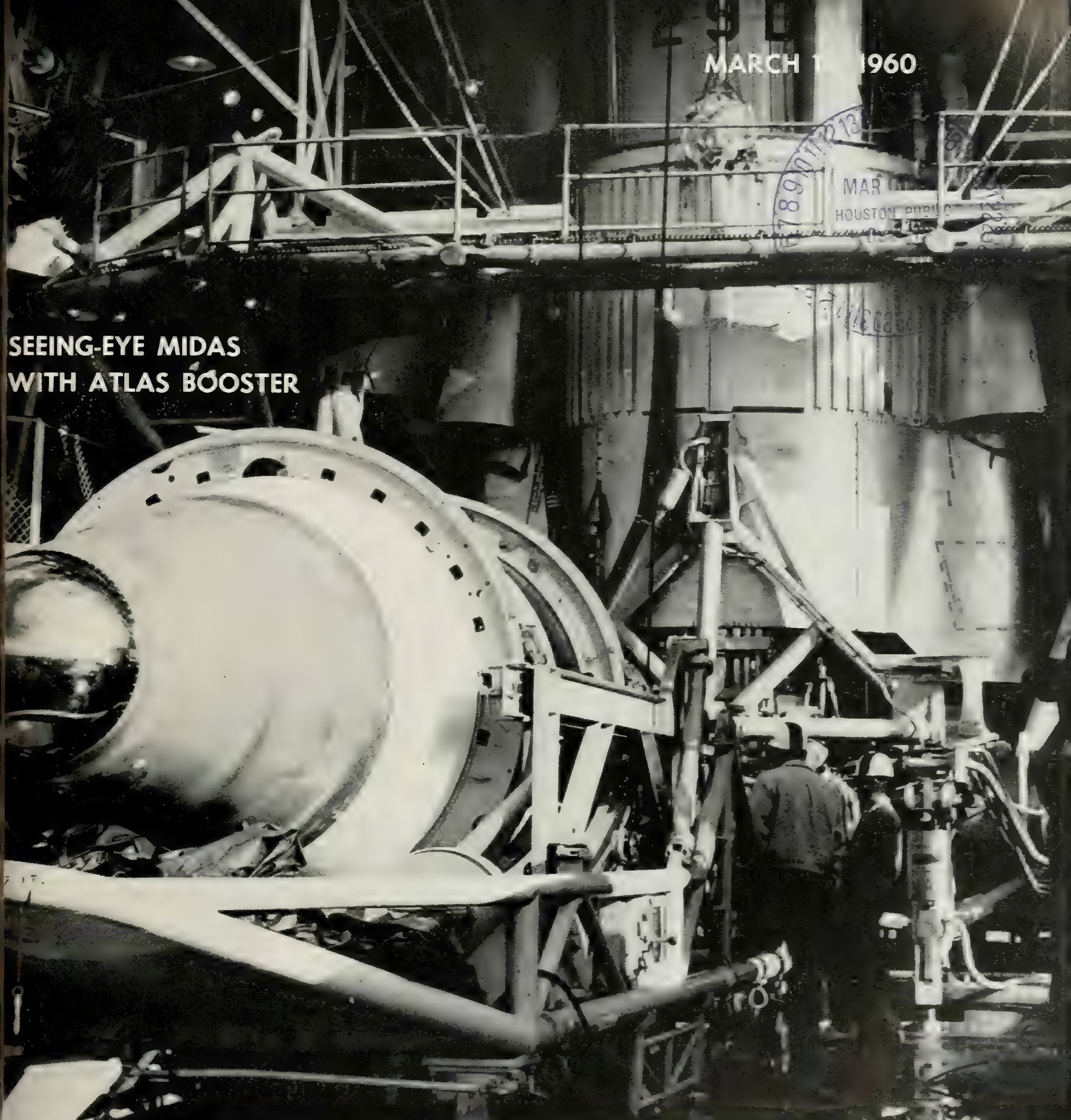

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION


PAD
1

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Missiles and Rockets Volume 6 Number 1

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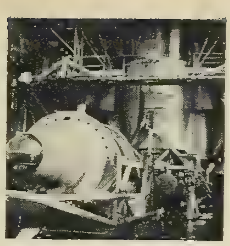
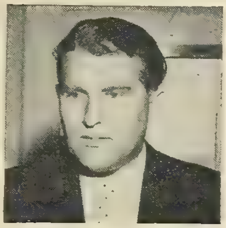
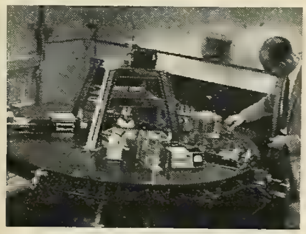


COVER: This *Agena* satellite vehicle was mated to an *Atlas* booster to form the first *Midas* carrier. It missed going into orbit from Canaveral Feb. 26, when *Agena* apparently failed to separate from *Atlas*.



LEADER of Huntsville's famed German-born rocket team is Dr. Wernher von Braun. The group this week assumes another historic task: developing big space boosters for NASA. See report beginning on p. 22.



STABLE platform for study of astronomical satellite is adjusted by NASA scientist at Ames Research Center. Civilian space agency plans to orbit such a satellite by 1963. See p. 26.

THRUST chamber mount of 1.5-million-lb.-thrust rocket engine test facility under construction at Edwards AFB, Calif., is inspected by Rocketdyne engineers. Turn to p. 36.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

30,000 copies this issue

MARCH 14 HEADLINES

ASTRIONICS

GROUND SUPPORT EQUIPMENT

ADVANCED MATERIALS

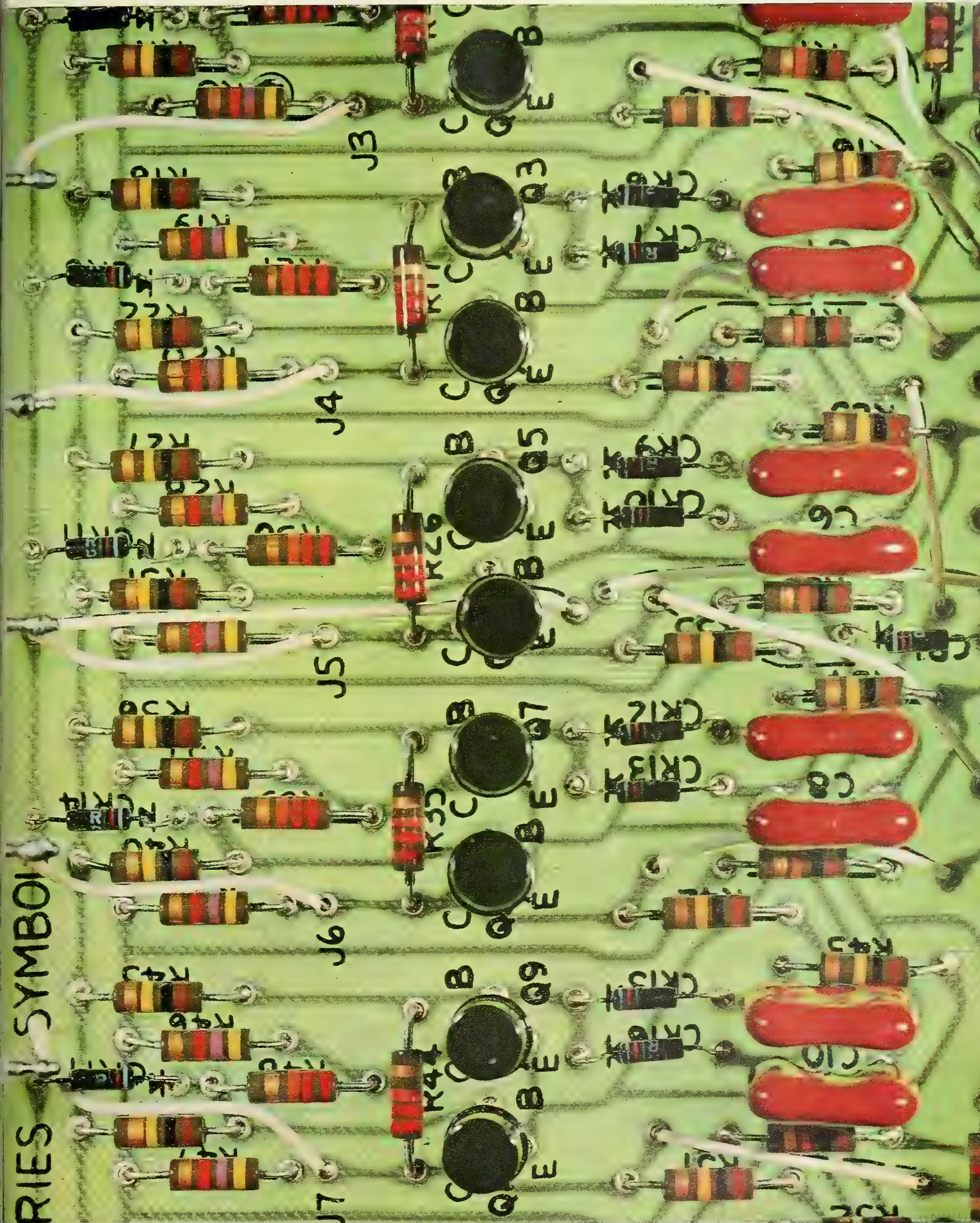
INTERNATIONAL

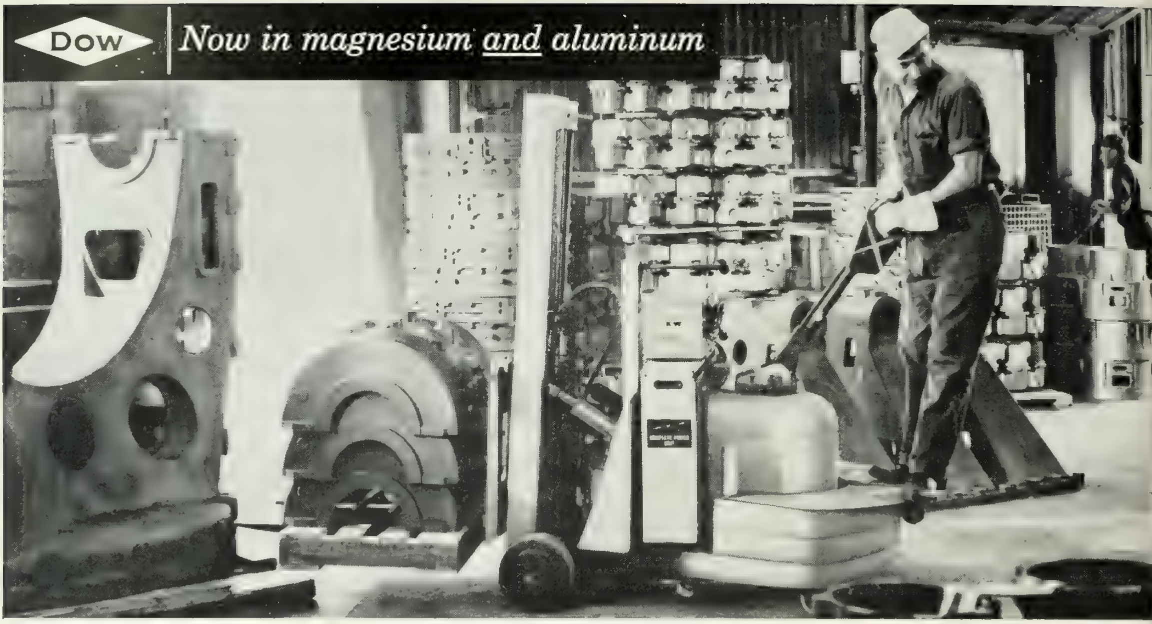
PRODUCTS AND PROCESSES

THE MISSILE WEEK

U.S. Reg. Pdg.

DEPARTMENTS





ARE YOU GETTING ALL THESE BENEFITS WITH YOUR MAGNESIUM CASTINGS?

Dow magnesium foundry offers experience, production capacity for sand and permanent mold castings of all sizes and shapes.

The unique capabilities of Dow's Bay City, Michigan, foundry help users of magnesium sand and permanent mold castings. Activities at this facility—largest and best equipped of its kind—run the gamut from large volume production jobs to one-shot "specials."

Huge or tiny castings. The foundry is capable of producing castings weighing in excess of 3,000 lbs. down to ounces—in all degrees of complexity. Experienced pattern engineers ensure that the best use of casting processes is made. This can result in either lower costs, improved quality, better deliveries, or a combination of all three.

Newest techniques. Many milestones in magnesium casting have been reached at this Dow foundry. In fact, Bay City has men permanently assigned to developmental work, keeping the foundry in the forefront of technological advances at all times.

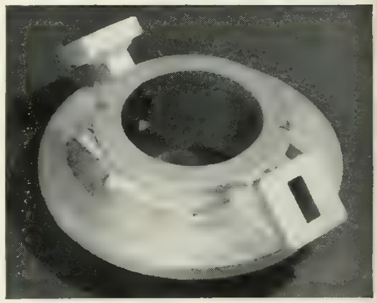
Results of their work include special processes for cast-in inserts and tubeless passages, and improved melting techniques. Casting methods have been developed for many of the newer magnesium alloys, such as the elevated temperature group and the new high damping capacity alloy, K1A.

Quality control. A full time quality control team exhaustively checks all work, from alloy composition to the shipping dock. A direct-reading spectrometer makes rapid alloy composition analyses. Its speed is particularly valuable when alloying elements that are hard to hold in the molten state, such as thorium, are present. Chemical analysis is also frequently employed.

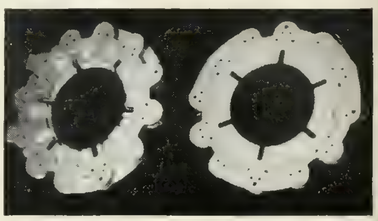
Testing facilities. Molding and sand cores are analyzed as a regular part of casting quality control. Radiography, fluorescent penetrant inspection and other testing facilities are used to check properties and specifications.

Experienced magnesium team. The foundry often draws upon the broad range of specialized experience available throughout the company. To Bay City customers, this means assurance of high quality work, done with utmost efficiency and economy. If your requirements involve magnesium castings, Dow can help you arrive at optimum casting design and reliably supply your production requirements.

FOR MORE INFORMATION, contact your Dow Sales Office or write today for illustrated brochure discussing Dow foundry services. THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Dept. 1001CL3-14



THIS SAND CAST WAVE GUIDE was held to ±.005" on passageway dimensions. Surface smoothness requirements are 63 RMS. The foundry has government approval for any phases of its operations where such approvals are applicable.



THIS BRAKE CARRIER is sectioned to show how the hydraulic lines were integrated by use of tubeless passageway casting techniques.

See "The Dow Hour of Great Mysteries" on NBC-TV

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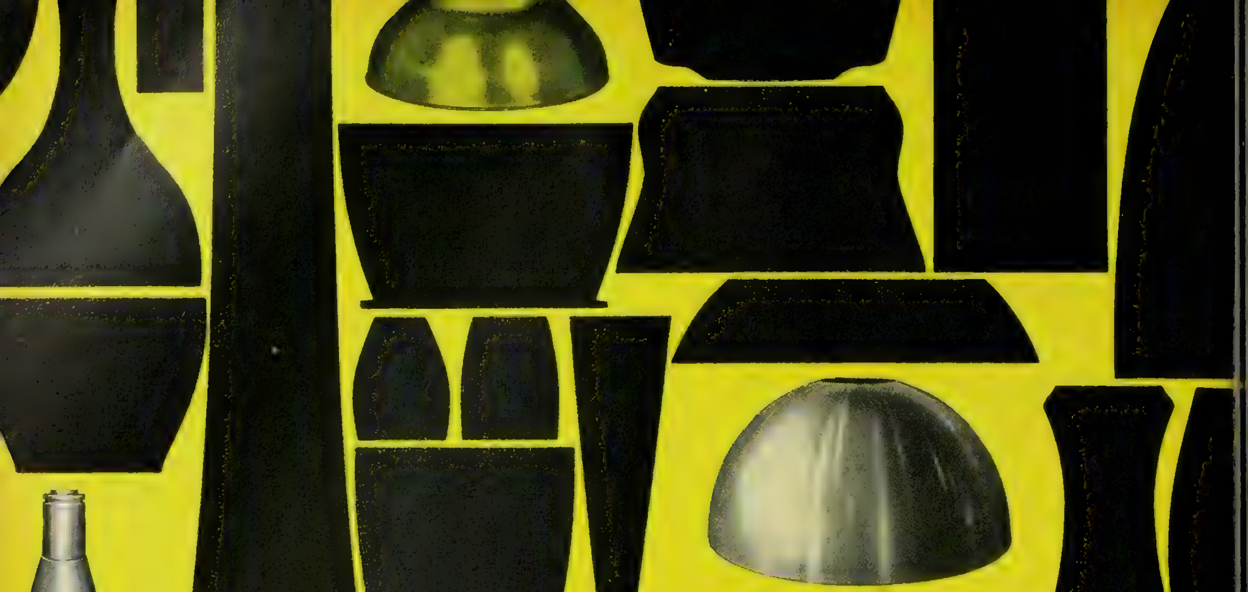

the missile week

Washington Countdown

IN THE PENTAGON

ICBM blowup . . .
at one of Vandenberg AFB's three operational *Atlas* pads earlier this month occurred during a high-speed loading test. The blast is believed to have been triggered by a loss of pressure.

• • •

King-size *X-15* . . .
has been designed by North American for possible use as a two-seater spacecraft. The big rocket plane would be boosted into orbit by *Saturn*.

• • •

***Dyna-Soar* pilots . . .**
are being trained at Edwards AFB, Calif. The pilot pool at Edwards also will provide crew members for later larger models of the planned *Dyna-Soar* space bomber.

• • •

Decision on the *SS-11* . . .
as an addition to the Army's arsenal of anti-tank weapons is expected within the next two months. The Nord wire-guided missile has a range of some 3800 yards—twice the range of the *SS-10*.

• • •

More boost for *Atlas* . . .
would be provided by a new Rocketdyne engine under consideration by Air Force. The new engine—the MA 3—is made of a newly patented aluminum alloy enabling it to provide nearly 400,000 pounds of thrust—an increase of 40,000 pounds.

• • •

First separation . . .
of the Martin two-stage *Pershing* in flight is expected within the next few weeks. The first R&D flight for the Army solid-fueled missile carried only a dummy second stage during its first R&D flight last month.

ON CAPITOL HILL

Clearer definition . . .
of the military role in space is being given extensive consideration by the House Space Committee. Several members object to what they call weasel-wording in the Administration's proposed changes in the National Space Act.

• • •

Senate will return . . .
to hearings on the Missile Gap and the Space Lag as soon as the civil rights debate ends. The Joint Senate Space and Preparedness Committee is understood to have kept Defense Secretary Gates standing in the wings for the last several weeks.

Space, not defense . . .
will probably be the next item of business on the Senate Space Committee agenda unless the civil rights debate ends quickly. Gates has to leave for Europe for the forthcoming Defense Ministers Conference, forcing the committee to switch its schedule.

• • •

***Bomarc-B*'s fate . . .**
will hang in the balance at a special congressional hearing planned for the end of the month. Powerful members of the House Defense Appropriations Subcommittee believe the Boeing air-breather may be obsolete before it is operational.

• • •

'Sole source' negotiation . . .
of contracts by the Defense Department will come in for some hammering by the Senate Small Business Subcommittee on Procurement next month. Subcommittee members feel the practice may discriminate against small business.

AT NASA

***Mercury*'s mounting cost . . .**
still does not include military expenses for maintaining the world-wide tracking range. In some cases, the military services are also paying for modification of their equipment for NASA's use.

• • •

Delivery of *Mercury* capsules . . .
is now understood to be the only thing holding up launching them on top of *Redstones*. So far, the first date for launching a manned capsule with a *Redstone* has not been set.

• • •

Military interest . . .
in the use of both *Saturn* and *Nova* is reported by NASA officials to be slight. The officials said their information is based on talks with unidentified Defense Department officials.

INTERNATIONAL

The British BMEWS station . . .
planned for construction in Yorkshire is under attack. British critics complain that the station will mainly benefit the United States—not Britain. They say it will give Americans 15 minutes warning of a missile attack; Britons, only four.

• • •

Woomera will get . . .
an 85-foot radar telescope built by the United States under a new U.S.-Australian agreement on space exploration. The $4.2-million telescope will be used for tracking shots from both the Woomera Range and Cape Canaveral.

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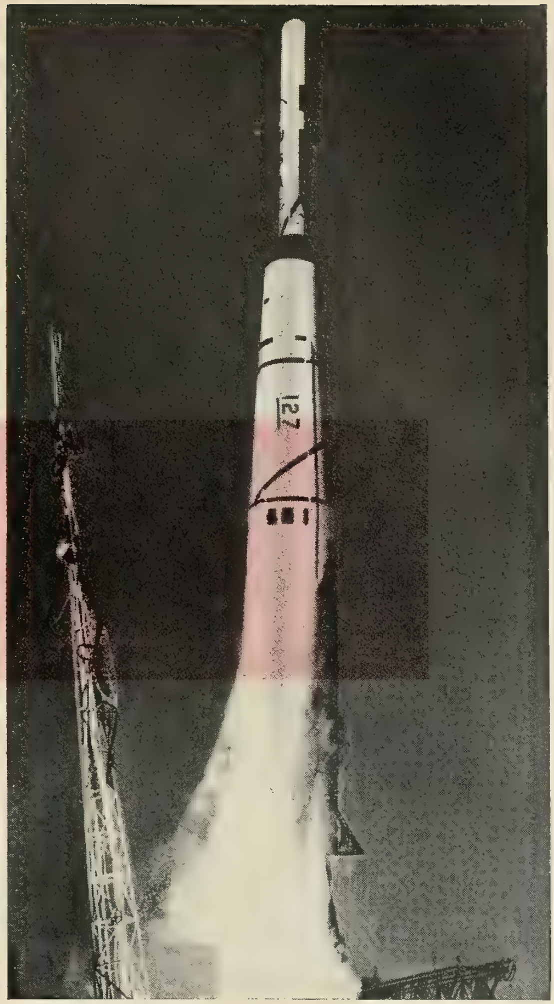

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Launching from Somaliland

To the Editor:

I read with much interest your editorial of Dec. 14, concerning the U.S. catching up with the Russians in space and rendezvous capability.

May I express my views on a point which was not touched upon in your editorial. It may well be the general view of all those who are not permitted—by national fate—to share and play the space game; who are on the edge observing the U.S. and Russian efforts in this field.

The probes and studies carried on so far—as you pointed out—have inevitably carried "us" to the focal point of the rendezvous in space. However, there is no reason why this (rendezvous) should be actually in space and not on the earth itself. Of course, in the latter case the assumption is not that we "catch up" in a race, but that we cooperate with Russia. Fortunately or unfortunately, space business is very costly, and the general feeling is that a point will soon be reached where not even the USA and the USSR will be able to carry out a national program of their own. Money, simply, will be lacking.

That's why, with a keen eye to the future, at the International Astronautical Congress of Amsterdam (1958) I and some U.S. colleagues started friendly discussion on the opportunity to arrive at an international equatorial launching site.

It will interest you to learn that I pointed out some time ago to the competent Italian governmental agencies the possibilities offered by locating a site in the Italian Somaliland. I suggested that a study on such a site should be officially presented to the U.N. and/or NASA. After general approval from the Italian Defense Department, the proposition was sent to the Italian Foreign Affairs Department; there were discussions about the actual carrying out of the study (not begun yet). Meanwhile, the Italian Foreign Office got in touch with the local Somaliland Government, which gave its approval for the installation, in case this should materialize.

The possibilities offered by the area of Kisimaio in the Italian Somaliland for the task of equatorial launchings are outstanding. In particular:

- Utilization of East-directed launchings (use of the rotational velocity of the earth) just over the sea;
- Exploitation as tracking stations of the islands to be found on a straight-on route over the Indian Ocean for an equatorial orbit, and down to the South for a polar orbit;
- Joining over a 7200-mile course (practically on the same parallel) the facilities of the eventual U.S. equatorial launching base at Manus Island, thus realizing the greatest range in the world. With respect to all other localities situated along the Equator, the Somaliland base offers the advantage of weather conditions permitting launchings throughout the year.

The Committee on Science and Astronautics of the U.S. House of Representatives, the NASA Committee on equatorial launch sites, the President of the International Astronautical Federation, all have been advised on this argument.

It is significant that, in principle, the Russians favour such a possibility. The logical way would be to start with the installation of an international tracking station, to be followed by the proper launching base.

I think the question presented herewith deserves a careful consideration; it may well be that through it the key of space is to be offered to all mankind.

Captain Glauco Partel
Via Livorno 61
Rome, Italy.

Solar Cell Information

To the Editor:

Our company is in the process of evaluating and defining the "Solar Cell" market. We would greatly appreciate any information; i.e., reprints, publications, new sources of information, etc., you could submit to us on this subject.

Your magazine has been an invaluable tool to our Marketing department. We greatly appreciate any assistance you would be to us in our project.

E. M. Hansen
Marketing Analyst
Military Products Division
Hoffman Laboratories Division
Hoffman Electronics Corporation
3740 South Grand Avenue
Los Angeles, Calif.

We have mailed a copy of "Report No. 1, Status Report on Fuel Cells," by the Army Research Office, a comprehensive document covering the field.—Ed.

In Re References

To the Editor:

The references to technical publications which appear in MISSILES AND ROCKETS articles are very useful, particularly those on Russian reports and translations. However, their value would be increased if you could give a source for obtaining the publications. Perhaps you could include a small section at the end of the magazine (similar to the photo-credits section of some journals) where you would list the publisher or translation source and price of reference.

This is an example of the difficulty we have in identifying and obtaining items referenced in magazines. Any assistance you may give in clarifying the reference will be gratifying, and your consideration of a regular source listing of references will also be greatly appreciated.

Jack M. McCormick
Chief Librarian
The Martin Co.,
Denver, Colo.

Many of M/R's translations come from government agencies and private sources whose budgets do not permit them to reprint translations. They usually request that such information not be revealed.—Ed.

IDL's Telemetry Role

To the Editor:

Engineering and production personnel of this company noted with interest the article appearing on page 54 of your February 29 issue. This page attempted to list a large number of contractors engaged in a manufacturing of telemetering equipment. We were interested in this listing to see the magnitude of the effort being put forth in telemetering and we were quite concerned because the name of this company did not appear on that list.

Our personnel are extremely proud of the record we have achieved in the past five years in building telemetering commutators. Some of this pride extends from the fact that IDL commutators were used when Able and Baker were fired into outer space in the *Jupiter* missile. Other commutators have been used during firings of the *Minuteman* and the silo launchings at Edwards Air Force Base late last year.

Still other commutators are currently being flown in the *Bomarc A & B*, both for telemetering and in the guidance radar equipments. Many of the *Snark* firings have carried our equipments during repetitive flights without service and/or repair. Even now, the *Pershing* program is counting on IDL switches to carry a major portion of the telemetering data.

We appreciate the magnitude of the effort that must have gone into preparing the chart as presented. In undertaking such a task, it is obvious that certain company names will be left off and we regret that it happened to be ours at this time . . .

Fred H. Gerring,
Marketing Manager,
Instrument Development
Laboratories, Inc.,
Attleboro, Mass.

Industry Countdown

MANUFACTURING

Newest market . . .

opening up is the operation and maintenance of missile units—particularly ICBM squadrons. The Air Force put the yearly O&M for one *Atlas* squadron of nine missiles at $25 million. Presently a total of 13 *Atlas* and 14 *Titan* ICBM squadrons are planned. O&M for them all could run to a total of $675 million a year. By comparison, O&M for aircraft in the AF, Army and Navy totals $633 million.

• • •

O&M FY 1961 funds . . .

required by AF ballistic missiles will total $100 million. The amount will keep on rising thereafter. DOD reveals that at the end of FY 1961, the SAGE (semi-automatic ground environment) system will need $157 in O&M support and this amount will rise until it levels off at about $250 million a year. Replacement parts are one of the biggest items and will stir up activity among subcontractors.

• • •

French *Entac* antitank . . .

missile is being taken over by Nord Aviation, according to reports. The missile was being developed at the French arsenal D.E.F.A. when Nord was asked to step in.

• • •

Airlift of *Thor* IRBM's . . .

to England is now complete. Sixty missiles to equip four British squadrons (15 apiece) and ground support equipment totaling 25 million lbs. have been flown from the Douglas Santa Monica plant in the past 18 months.

• • •

Only 11 companies . . .

submitted bids on the multimillion contract to build the airframe for the NASA *Saturn* upper-stage cluster of 20-K engines. Twenty had been invited to submit bids. One which was not invited, Grumman Aircraft, did submit a proposal. Other bidders are Lockheed, Pratt & Whitney, Boeing, Douglas, North American, McDonnell, Chrysler, Bell, Convair and Martin.

PROPULSION

There's no thrust spec . . .

on Project 3059, the AF's feasibility study for a multi-meg solid-rocket motor. The AF instead specified only total impulse, the product of thrust and burning time. While total impulse is classified, bidders are said to be divided between high thrust and relatively short burning time on one hand, and lower thrust and longer burning time on the other.

• • •

Pictures are being withheld . . .

of the AF *Minuteman* ICBM silo shots, it's reported, because the missile emerges "black as a burned potato" from backlash of first-stage motor. In first full-size, three-stage tether shot from a silo, the missile climbed several hundred feet on a "short-charge." The casing cracked when it was pulled back to earth. The test, sixth in tether series, was considered a success anyway.

ASTRIONICS

First ICBM all-inertial . . .

guidance package went aloft last week as a passenger in an *Atlas*. The Arma system monitored the radio inertial system during the 6300-mile flight from Cape Canaveral. It will be checked out in a controlling role within a few weeks.

• • •

Tests to recover . . .

a NERV (nuclear emulsion recovery vehicle) package which will be used by NASA for radiation belt studies are being made off of San Nicholas Island along the Southern California Coast. Dummy packages are being dropped from 37,000 ft. by an AF F-104. Recovery system consists of a parachute, electronic beacon, flashing light, radar chaff and dye marker for visual pickup.

WE HEAR THAT

Grand Central Rocket . . .

has successfully fired a case-bonded Nitrasol solid gran at –68°F after repeated cycling from –75° to +165°F . . . Washington Technological Associates just outside the Nation's Capital is planning a 5-year $3 million building program . . . Westinghouse's semiconductor plant at Youngwood, Pa., is being expanded by 30% . . . The British are now producing their own nuclear warheads for all operational missiles, including *Thor, Bloodhound, Firestreak, Seacat, Seaslug, Thunderbolt, Malkara, Corporal* and *Little John*. . . .

Defense Needs $25 Billion More

This 5-yr. price tag estimated by Lanphier in stormy Congressional session

by James Baar

The great fight over the Deterrent Gap moved toward a new roaring pitch this week as Congress studied the $25 billion-plus price tag placed on survival by Ex-Convair Vice President Thomas J. Lanphier, Jr.

Members of both the House and Senate prepared to renew the bitter fight over the Administration's defense policies as soon as a civil rights bill in some form is passed.

Lanphier, who quite his job at Convair to fight for bigger defense spending, laid his proposals before the House Space Committee at an angry two-hour hearing filled with bickering and cries of "politics" from Republican members. The name of Sen. Stuart Symington of Missouri, contender for the Democratic presidential nomination, came up repeatedly.

The young-looking 45-year old industrial executive accused President Eisenhower of gambling with the nation's very life and called for immediate defense increases across the spectrum of war. He specifically urged:

- Acceleration of both the Convair *Atlas* and Martin *Titan* programs "by all means" and greater funding for the Lockheed *Polaris* and Boeing *Minuteman*. He said Convair could produce five more *Atlas* squadrons by the end of 1962. (This would call for a concurrent increase in hardened bases.)
- Acceleration of the Air Force programs to develop the Lockheed *Midas* early warning and *Samos* reconnaissance satellites.
- The launching of a SAC airborne alert comprising nearly half of SAC's force.
- Purchase of more B-52's and B-58 jet bombers and KC-135 jet tankers, develop the B-70 Mach-3 bomber and the advanced B-58.
- Begin purchasing "airlift for the Army and the Marines, something we haven't done in the budget for the last five years to any noticeable degree."
- "Make certain with dollars" that the U.S. space program is achieved.
- Launch a "sensible civil defense shelter program as a very significant element of the deterrent—something we don't have, something the Soviets most certainly do have."

• **Price Tag**—Lanphier placed a $4 billion to $5 billion a year price tag on his proposals. He said the spending should continue over the next four or five years.

Some qualified observers called his estimate of cost conservative. They said a civil defense shelter program that had any meaning would cost $2 billion to $5 billion a year.

Lanphier said the United States already was "in the process of losing World War III," and could logically be assumed "to be in jeopardy of physical destruction."

He said Russia conceivably could have begun producing ICBM's in late 1957 after launching *Sputnik I*. He said if Convair had been able to begin *Atlas* production in late 1957 the U.S. stockpile today would top 400—almost three times the number of ICBM's that Gen. Thomas Power, commander of SAC, said would be needed to wipe out all U.S. retaliatory power in North America.

Lanphier told the committee that he decided to carry on his personal campaign for more defense spending because "throughout this past decade and particularly over the past five years (he had) watched with growing concern the perennial development of defense budgets more and more out of joint with the technological times." He said these budgets were "less and less sufficient to meet the growing threat in the significant areas of ICBM's, anti-submarine warfare and limited war deterrent."

The World War II fighter ace said pointedly that three years ago Gen. Curtis LeMay, now Air Force Vice Chief of Staff, warned "unless our defense program changed from what was then planned the winter of 1959-1960 could find us inferior to Soviet Russia in modern military power."

"In the intervening three years, the only changes in our defense effort have been to diminish it from what it was planned to be," he added.

Lanphier, sitting at the center of the hushed crowded hearing room, flatly blamed President Eisenhower in a series of unequivocal answers.

• **Q & A**—Rep. Erwin Mitchell (D-Ga): "Do you think that the Administration with its policy of defense, its overall policy, is jeopardizing the national security?"

Lanphier: "Yes, sir, I do."

Mitchell: "Do you think that President Eisenhower knows as much about defense as he says he does?"

Lanphier: "No, sir, I do not."

Mitchell: "Do you think the President is taking a gamble?"

Lanphier: "Yes, sir, I think the President is taking an unwarranted risk."

Lanphier said the Administration was to blame on two counts: "Wrong decisions and decisions not made." He cited as an example the decision this winter to build four more *Atlas* squadrons—a year and a half after the proposal to build more *Atlas* squadrons was made.

He said "we never could get agreement" a year and a half ago for a proposal to build eight more. But he said Congress last spring ordered eight more and "this winter the President accepted the money for four."

"I wish he had decided that last year, accepted them last year and accepted all eight of them," he said. "We would be that much better off next year than

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What Industry Says

Officials of the Defense Industry, contacted by M/R have mixed emotions regarding the outbursts of Thomas J. Lanphier and their usefulness to either industry or the nation.

Most agreed that the U.S. lags dangerously behind in military preparedness. The questions came as to Lanphier's motives and methods.

Said one: "When he started I took him at face value. I thought he was what he seemed—a modern Don Quixote. Now I'm beginning to fear he cannot escape a self-interest."

"He's just doing what he's been doing for the past five years," said another company spokesman. "He's always been fighting for more defense—even when it meant fighting for his competition. He may wake some people up."

And another: "I think he's making a damn fool out of himself, but I'm all for it. It's good for business and I'm glad it's happening. But the key question, which no one seems to be asking, is: 'How does he know?' No one in industry has access to information of a broad enough nature to be so authoritative. I doubt if Tom's in a position to know what he's talking about."

Voicing a thought that others had hinted at, an old acquaintance said:

"It's all just part of a build-up for Symington."

we are going to be—which is pitiful."

Rep. James G. Fulton (R-Pa.), a high-ranking member of the committee, repeatedly questioned Lanphier on whether his motives were more political and involved more politics than disinterested patriotism.

"Do you have any ideas as to your future?" Fulton asked, bitingly. "Some of us would like to make sure whether this is not the first shot heard round the world (in) a political campaign for a man named Symington."

Lanphier said he respected Symington, agreed with his defense policies and would vote for him for President. But he insisted he spoke only for himself and had no plans to work on Symington's staff.

He said when men in the military services or defense industry called for more defense spending "people think they are grinding an ax."

"This is a valid assumption that a guy has some angle, he is trying to sell missiles or sell his service and it could be so. The unhappy fact is that the very people who are authoritative in the field are these people in industry and in the service."

Atlas Range Upped 1/3

by James A. Fusca

Maximum range of the USAF—Convair *Atlas-D* ICBM, about four of which are now on or near operational status at Vandenberg AFB in California, has been increased by approximately one-third through improvements made over the past year. This represents an increase of about 3000 miles over the maximum range of 6325 statute miles announced by USAF in the past.

Contrary to previously published reports, the *Atlas-D* now set for a 9000 statute mile flight from its launching pad at Cape Canaveral is not a stripped-down version but a fully operational missile which will use an operational nose cone weighted with ballast in place of its hydrogen warhead. This bird will also carry the instrumentation load of about 1000 lbs. that is standard to test missiles fired over the Atlantic Missile Range.

This launching, said to be awaiting Presidential approval, will be the first full range test of the improved *Atlas-D* now being furnished to the Strategic Air Command as a deterrent weapon. The Administration reportedly hopes by this flight to counteract the effect on world opinion of the Soviet Union's 7766 statute mile "super rocket" experimental firing into the Pacific last January.

One reason offered by Administration sources for USAF's delay in receiving Presidential approval for the long range shoot is that no warning has been circulated as to times of firing and the impact area. Employing an operational nose cone, the payload section will re-enter and impact in the ocean where flotation gear will be used for recovery or it will be permitted to sink. These sources point out that the Soviet Union issued warnings on its firing, and that there might be an adverse reaction if the United States did not also.

Planned trajectory for the *Atlas* flight will carry it to an impact point in the Indian Ocean, south and east of Africa's Cape of Good Hope, along a line that passes northeast of the closest point of South America and south of the Cape of Good Hope, circumventing problems that would arise from flights over friendly territory.

The *Atlas-D* is powered by the Rocketdyne MA-2 engine, delivering slightly more than 360,000 lbs. of thrust. The follow-on *Atlas-E* will be powered by the MA-E which Rocketdyne has announced will generate approximately six per cent more thrust than the MA-2 and weigh about 100 lbs. less. The company reportedly expects, however, to increase this thrust to more than 400,000 lbs.

Atlas-43D, launched over the full 6325 statute mile range around the first of the year, reportedly had almost 10 seconds of fuel remaining in its tanks at cutoff of powered flight. Each second of burning time of the sustainer engine at altitude, where it would have approximately 80,000 lbs. of thrust, would add about 200 miles to the range capability.

• **Von Neumann Committee**—During 1954 and 1955 the Von Neumann committee laid down what it considered to be optimistic estimates of the capabilities of the first U.S. intercontinental ballistic missiles. Comparing these estimates with the results to date:

• **Reliability** — The committee thought that the first ICBM's might have a reliability of 50%. Last week's firing of *Atlas-46D* in the first test of American Bosch Arma's all-inertial guidance system was the 18th successful flight in a row.

• **Range**—The comittee anticipated a maximum range of 6325 statute miles. If successful, the extended range *Atlas-D* firing will better this maximum by about 50%.

• **Accuracy**—The committee considered that a high probability of striking within a radius of five miles of the desired point of impact at 6325 miles was a reasonable goal. Actual firings at this range have indicated an accuracy of within two miles.

• **Warhead yield**—One of the important factors in accelerating the ICBM program in 1954 was the success of *Operation Castle* which proved the feasibility of reasonably small and relatively light nuclear warheads for missiles. Marked increases in warhead yields for the same size and weight have been achieved in the interim.

—news briefs—

PATENT CHANGE—A House Space Subcommittee has recommended a compromise change to bring NASA's patent rules more in line with DOD's. Under the proposal the patent status of each invention developed under NASA contracts or subcontracts would be written into the contract. The subcommittee proposed several conditions under which NASA could waive title to the inventions or retain title.

BOEING EARNINGS DROP—A sharp drop in its 1959 earnings—about $17 million—is reported by Boeing Airplane Co. The company said in 1959 profits were $12.4 million on sales of $1.6 billion against 1958 profits of $29.3 million on sales of $1.7 billion. Backlog on Dec. 31 was $2 billion compared to unfilled orders of $2.4 billion on the same date the year before. The 1960 outlook is for increased earnings, the company said.

EXPLOSION WHY—The Feb. 26 failure of an *Atlas-Agena* carrying the prototype of a *Midas* "spy-in-the-sky" infrared satellite has been attributed to an explosion of small retrojets designed to separate the two stages. The explosion ripped into the *Agena's* fuel tanks, destroying the satellite.

BURKE DISPUTES AF—Chief of Naval Operations Arleigh Burke disputed the Air Force claim that 300 Soviet missiles could wipe out U.S. retaliatory forces. He said there were more nuclear bomb carrying planes aboard five Navy carriers in the Mediterranean and Far East than in Russia's entire heavy bomber fleet.

MISSILES TO GERMANY—Two Army *Lacrosse* battalions are embarking for Europe in the next two months. They will be located in Germany. Each battalion will have four launch trucks and an undetermined number of missiles.

STL MAY BE RETAINED: Details of a plan which would permit Thompson Ramo Wooldridge, Inc., to retain its wholly owned subsidiary, Space Technology Laboratories, Inc., are expected to be announced this week. Any such agreement or reorganization proposal must have USAF approval in line with STL's engineering and management responsibilities in Air Force ballistic missile program.

A spokesman for TRW declined to say if STL would be retained intact by the parent company or if some functions would be turned over to the USAF. The TRW-STL relationship has been under some fire on possible "conflict of interests" between STL functions and TRW's production of missile components.

NORTH AMERICAN TO BUILD: Negotiations between North American Aviation and the City of San Diego for purchase of a 40-acre site on San Diego's Torrey Pines Mesa are reported to be beyond the discussion stage. If complete agreement can be reached, new research facilities for the company's Autonetics division will be constructed on the site.

INTERSTATE BUYS: Interstate Engineering Corp. of Anaheim, Calif., has contracted to acquire Autronics Corp. of Los Angeles, manufacturer of small electronic devices for missiles and aircraft.

LITTON GROWS: Litton Industries has signed an agreement with Western Geophysical Co. of America for the exchange of 100% of Western Geophysical's outstanding stock for Litton common stock in an undisclosed amount. Western Geophysical is a privately held company engaged in geophysical exploration and electronics instrumentation development and manufacturing. Its sales totaled $15 million in 1959.

FORD STARTS NEW GROUP: Ford Motor Co. has established a Defense Products Group headed by Gerald J. Lynch, company VP and general manager of Aeronutronic Div. The new group will be responsible for all defense programs and will develop commercial product opportunities arising out of defense activities.

BRITISH C-E-I-R: A subsidiary company in London has been formed by C-E-I-R of Arlington, Va. This subsidiary will carry on much the same services as the parent company.

MAXSON PLAN APPROVED: A plan for combining Electronic Communications, Inc., and the W. L. Maxson Corp., on the basis of exchange of one share of ECI common stock for each 1¾ shares of Maxson capital stock has been approved by the boards of directors of both companies.

ELECTRONICS FIRMS MERGE: Control Corporation has become an independent subsidiary corporation of Control Data Corp., by an exchange of stock. Consolidated Diesel Electric Corp. has acquired control of Ultradyne, Inc. of Albuquerque. Antenna Systems, Inc. has purchased Spinform Division from Pan-Tex Manufacturing Corp. and will move the equipment to the Hingham Industrial Center.

QUARTZ SUPPLIERS BOUGHT: Pacific Industries, Inc., San Francisco, has acquired Midland Manufacturing Co. and Wright Electronics, Inc. of Kansas City, the nation's largest producers of quartz crystals for the electronic industry.

COLVIN FORMS COMPANY: Formation of Pressure Elements, Inc., has been announced by the president of Colvin Laboratories to produce pressure components.

ALTO SCIENTIFIC DIVIDES: Two new divisions, Subsystems and Components, have been formed by the Alto Scientific Company of Palo Alto, Calif.

SPACE ELECTRONICS REALIGNS: Space Electronics' five new major departments will be named: Subsurface Communications, Terminal Guidance, Telemetry and Instrumentation, Satellite and Space Systems, and Advanced Study and Development.

TASKER CONSTRUCTING: Construction has begun in the Van Nuys area for the new consolidated facilities of the Tasker Instruments Corp. The now separate administrative, engineering and production departments will be housed in the facility.

CABLING DIVISION STARTED: Missile Systems Corp. of Los Angeles, manufacturers of electronic systems for the missile and aircraft industry, has announced the organization of a new cabling division to operate at the company's North Hollywood plant.

NEW PLANT FOR TRANSVAL: Transval Electronics Corp.'s manufacturing, research and administrative facilities will be consolidated into an existing building in El Segundo, Calif.

REMCO GROWS: The complete cylinder line of the Turlock Iron & Machine Works—HYPOWER Hydraulic Cylinders, have been purchased by Remco Manufacturing Company.

NEW AIR SEPARATION PLANT: Air Reduction Pacific Co., division of Air Reduction Company, Inc., has dedicated a $3-million plant in Richmond, Calif.

NORTHROP PURCHASES: The three plants formerly owned by American Standard at Norwood, Mass., as its Military Products Division will begin operation as the Precision Products Department of Northrop's Nortronics Division. The transaction was made in cash.

TELEMETER MERGES: Telemeter Magnetics has merged two of its subsidiaries, Invar Electronics Corp. and Digital Instrument Laboratories, into a new organization to be known as Invar Electronics Corp.

NEW JERSEY FIRMS UNITE: Thermal Controls, Inc. and O.K. Electronics Corp. of Nutley, will be known as Thermal Controls, Inc.

GARRETT MOVES INTO JAPAN: Far East headquarters have been established in Tokyo by the Garrett Corp., forming the subsidiary Garrett (Japan) Ltd.

LEAR OPENS TOKYO OFFICE: Lear, Inc. is also establishing offices in the Far East after having maintained a field service representative in the area for some time. Pumps and check valves developed by Lear, Inc., will be manufactured in Canada by Lucas-Rotax, Ltd., of Toronto, Ontario.

CAMLOC LEASES GERMAN PLANT: A plant has been leased at Kelkheim, West Germany, by the Camloc Fastener Corp. of Paramus, N.J. The European subsidiary will manufacture under the name Camloc Fastener GmbH.

PACIFIC AUTOMATION EXPANDS: Pacific Automation Products, of Glendale, Calif. are forming an architect-engineer division to study and design construction projects for government agencies, the armed services and industry.

ASTROMETRICS, INC., FORMED: Astrometrics, Inc. of Santa Barbara, Calif. has been formed by the Arnoux Corp. to specialize in telemetry and advanced instrumentation systems and components complementing the Arnoux line.

B-W FORMS DIVISION: Borg-Warner Corp. has formed a new division known as Borg-Warner Controls, Santa Ana, Calif. It will take over personnel, products and existing facilities of the BJ Electronics plant of the corporation.

Von Braun team: from V-2 to Saturn

Group Taking On Another Vital Role

DR. WERNHER VON BRAUN

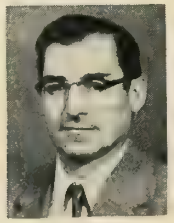
EBERHARD REES

DR. ERNST STUHLINGER

DEBUS

GEISSLER

HAEUSSERMANN



HEIMBURG

HUETER

HOELZER

LANGE

MAUS

NEUBERT

MRAZEK

by Paul Means

Today a group of American rocket experts of German extraction will be reassigned—probably for the last time in their stormy and portentious career.

The Wernher von Braun team, which produced the first sizable military rockets for the German Army and the first operational IRBM for the U.S. Army, will begin its new task of developing large space boosters for the National Aeronautics and Space Administration.

The 89 original German members of the Von Braun team and their 5000 colleagues at the Development Operations Division of the Army Ballistic Missile Agency are being transferred by the President in order to cement in one space agency the nation's super booster program. Because of the difficulty of transferring large governmental organizations during the middle of a fiscal year, the transfer will not be completed until July 1.

The principal members of the Huntsville team, in the order that their pictures appear above, are: Dr. Wernher von Braun, Director; Eberhard Rees, Deputy Director; Dr. Ernst Stuhlinger, Chief of the Research Projects Laboratory; Dr. Kurt Debus, Chief of the Firing Laboratory; Dr. E. D. Geissler, Chief of the Aeroballistics Laboratory; Dr. Walter Haeussermann, Chief of the Guidance and Control Laboratory; Karl L. Heimburg, Chief of the Test Laboratory; Hans Hueter, Chief of the Systems Support Equipment Laboratory; Dr. Helmut Hoelzer, Chief of the Computation Laboratory; Dr. O. H. Lange, Project *Saturn* Director; Hans H. Maus, Chief of the Fabrication and Assembly Engineering Lab-

oratory; Erich W. Neubert, Chief of the Systems Analysis and Reliability Laboratory; and William A. Mrazek, Chief of the Structures and Mechanics Laboratory.

During the last 15 years, the Von Braun team has traveled from Peenemünde, Germany, to Washington, D.C., from Ft. Bliss, Tex., to Huntsville, Ala. Its participation in the American rocket effort began in 1945 when its leaders decided to strike West and surrender to the Americans rather than stay where they were and be captured by the Russians.

• **From "affront" to immigrants**—The team which was to make some of the most significant contributions to the U.S. missile and space effort was not originally welcome. While the group was stationed at the Naval Gun Factory at Washington, D.C., the Federation of American Scientists protested to the U.S. government that its presence was "an affront to the people of all countries who so recently fought beside us."

The Germans were transferred to Ft. Bliss, Tex. They worked eagerly under the approving eyes of their Army superiors at the White Sands, N.M., missile range.

Time passed, and the conquered had demonstrated their sincerity to the conquerer; in 1948 the team was allowed to achieve the official status of immigrants by walking across a bridge over the Rio Grande River from El Paso, Tex., to Mexico, and then reentering the country on the same bridge.

The official immigrants—port of entry Texas—were transferred to the Army's new rocket center at Huntsville in 1950. Here the effort to develop large-scale missiles and satellites began in earnest.

• **Proud record**—The record of the Von Braun team during its 10 years at Huntsville has been the most impressive of any similar group in the country. A partial list includes: development of *Redstone,* the first large field missile; the first successful launching of an IRBM, the 1500-mile *Jupiter;* the first solution to the aerodynamic heating problem of re-entry; the free world's first satellite in orbit around the earth; the free world's first satellite in orbit around the sun; and the first recovery of primates after journey into space.

In Huntsville the German team found a new home. Their families joined them, in some cases after years of separation, and they began to enter into community activities.

Today, many of those activities Huntsville is proudest of, including the symphony orchestra, the string quartet, the Mt. Sano Observatory, and the four-lane freeway on the edge of town, were accomplished in part or in full by the new German neighbors.

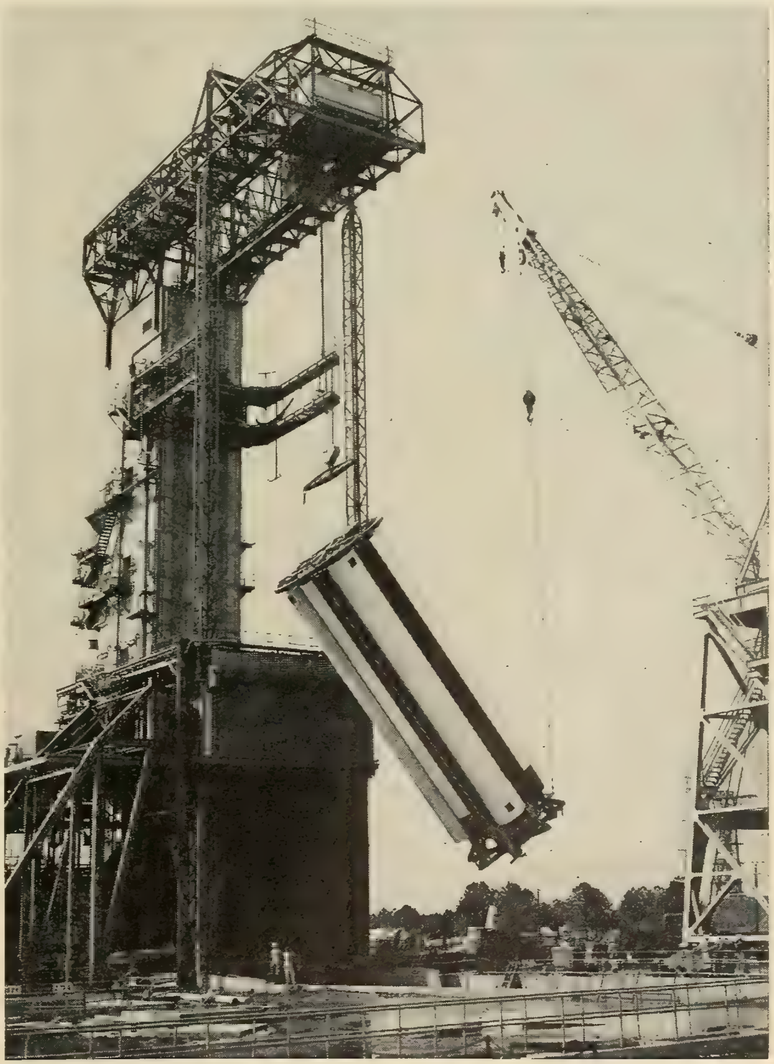
In 1955, the ex-German rocket experts and their families became citizens of the United States.

• **Strength through union**—Project *Saturn,* the team's latest and most significant effort, and the one which eventually led to their transfer to NASA, was started in 1958.

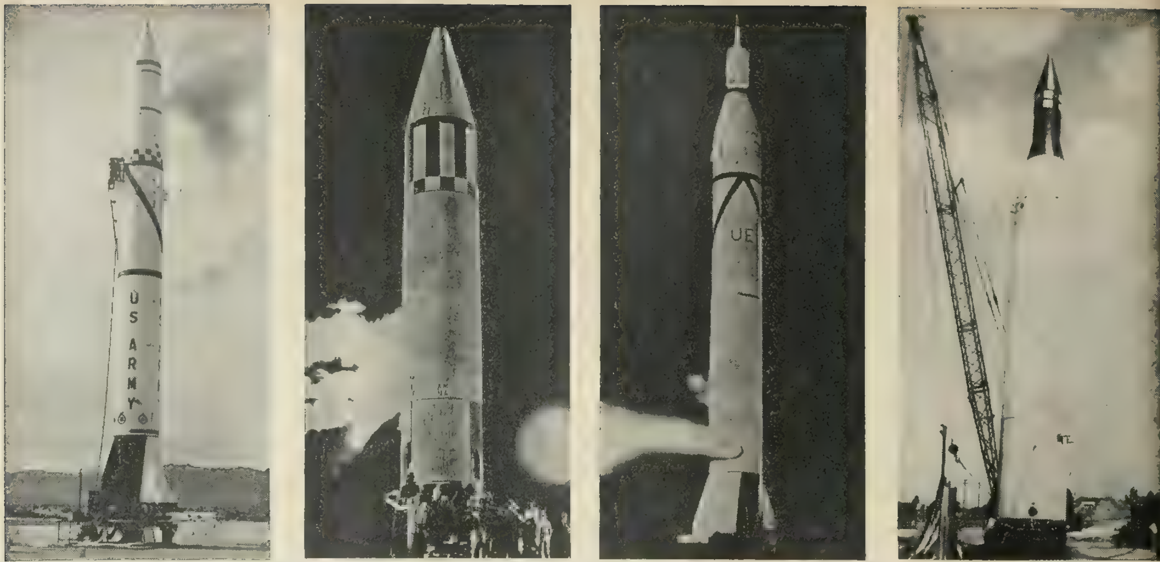
It had become increasingly clear during these first few years of space flight that the U.S. effort was deficient in rocket thrust. Where the Red satellites orbited payloads of a ton or more, the U.S. satellites orbited payloads of only a few pounds.

The Von Braun team, along with other U.S. rocket experts, realized that large engines with a million pounds of thrust or more were a long way off. In 1958, no such rocket engine was under consideration, and the eventual million-pound-thrust engine for Project *Nova* is not expected to be operational before the late 1960's. To crash the time barrier, Von Braun and his associates suggested to ARPA that the *Jupiter* IRBM engine be improved, and that eight *Jupiters* be clustered into a giant booster producing one and a half million pounds of thrust.

The concept of clustering, with which the Von Braun team proposed to save time, was not new. When it became unfeasible to build larger ship or aircraft engines, greater power was produced by combining the output of more than one engine. The Von Braun team merely applied this principle to rocketry. They assumed that by mating existing reliable rocket engines into a larger single stage with a much higher thrust level, one produced



GIANT CRANES lift the first *Saturn* booster rocket into position in the static test tower of ABMA at Redstone Arsenal.



EARLY SUCCESSES of the German-born team: *Redstone, Jupiter, Jupiter-C,* **and** *Juno II.* **These solved many problems** *Saturn* **is facing. All are descendents of the Von Braun team-developed German V-2.**

the largest feasible rocket booster in the shortest time.

But the *Saturn* proposal was not just a stop-gap measure. Because the cluster could perform certain missions, or land under guidance after failure of one or two of its engines, the clustered engine added a greater degree of safety and reliability to manned space flight.

• **Weak in funds**—ARPA bought the idea in August, 1958, and the project was on its way. The original schedule would have flight tested the booster in late 1960; with operational flights following in 1962-63.

But, after one year, the project faltered because of inadequate funding and divided military authority.

In FY 1959, $34 million was requested by Von Braun's team and $34 million was received. The second year (FY 1960) $140 million was requested, but only $70 million was received. The third year (FY '61) the team requested $250 million. If the program had stayed under Defense-ARPA management the project would have received only $140 million.

In the face of niggardly appropriations, the Von Braun team tried to cut costs. They tried to make research paid for by NASA and the Departmen of Defense in other areas pay off also for *Saturn.* They put in overtime without billing the government. But all of this could not make up for the millons of dollars the project had been short-changed.

The Army had been kicked out of its space role. It was therefore a little incongruous that the major Army rocket team should spend most of its time working on a space project.

• **Near thing**—Project *Saturn* was almost sent to an early grave when the Department of Defense, prodded by the dollar-conscious Bureau of the Budget, decided that the military would have no need for such a large rocket before 1965. Also jeopardizing its future was an arbitrary 1959 DOD ruling that no military missions existed beyond 600 miles—leaving *Saturn,* a military project, with no military mission.

Out of frustration, *Saturn's* backers turned to NASA as the last chance to accelerate the program. As Maj. Gen. John B. Medaris—a believer in military space—put it, transfer to NASA was "the least obnoxious alternative."

Finally, the chemistry of an election year plus growing public concern about Russian space achievements transferred the Von Braun team to NASA. The series of events leading to the transfer culminated in November, 1959, when President Eisenhower gave NASA the space booster program, the Von Braun team, and *Saturn.*

• **Finding a home**—Von Braun and his colleagues found NASA a benevolent master. At last they had an overseer who believed in, and was willing to fight for the *Saturn* program. Overtime was approved, and NASA asked Congress for $246 million for *Saturn,* just $4 million short of what Von Braun and his colleagues had asked for. For good measure, NASA threw in another $8 million out of its liquid propulsion budget.

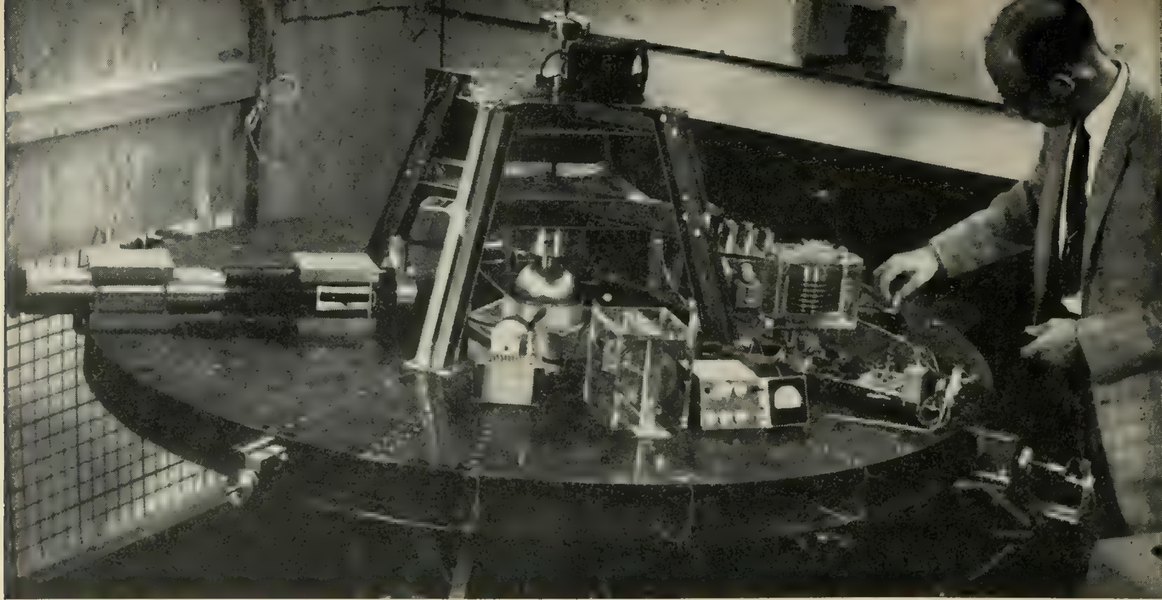
For the first time, the team had enough money for one of its space projects. When asked by a member of the House Space Committee Feb. 8 whether he could use more money, Von Braun replied that *Saturn* now had all of the money that could profitably be spent and that additional money would "probably be wasted."

Von Braun also told the committee that he was "thoroughly satisfied" with the transfer, and urged Congress to approve the President's action as soon as possible. Complimenting NASA for making "clear decisions" immediately upon taking over, Von Braun said his team and the space agency had quickly arrived at a "unanimous decision" on *Saturn's* upper stages.

• **Genealogy**—These upper stages, as they become available, will consist of a cluster of four 200,000-lb.-thrust engines, a cluster of two 200,000-lb. engines, a cluster of four 20,000-lb. engines, and a cluster of two 20,000-lb. engines. The entire vehicle will weigh over 600 tons and will stand over 200 feet tall—nearly half as high as the Washington monument.

The giant booster can be traced back to its granddaddy—the Von Braun team's *V-2.* The eight Rocketdyne H-1 engines are repackaged, uprated and simplified versions of the engine developed at Peenemünde. The first U.S. version was the *Navaho* by Rocketdyne. Then came the *Redstone, Jupiter, Thor* and *Atlas,* all newer versions of the *V-2* engine.

Under the direction of NASA's propulsion chief, Maj. Gen. Donald R. Ostrander, the Von Braun team will have supervision of all super booster projects, including *Nova* and newer boosters not yet prescribed. Under NASA, the Von Braun team apparently has found the niche where it can most help the U.S. space effort.



NASA SCIENTIST AT Ames Research Center makes adjustment on stable platform used in study of astronomical satellite. Long black tube is telescope for sighting artificial light source. Note support structure for the air-bearing surface. Reaction wheels are in housings on top of the platform.

NASA Preparing Astronomical Satellite

by Frank G. McGuire

MOFFETT FIELD, CALIF.—The National Aeronautics and Space Administration is developing a controllable astronomical satellite which it expects to place in orbit by 1963, putting a payload of about 3500 pounds into a 500-nautical-mile circular orbit aboard an *Atlas-Agena-B* from Cape Canaveral.

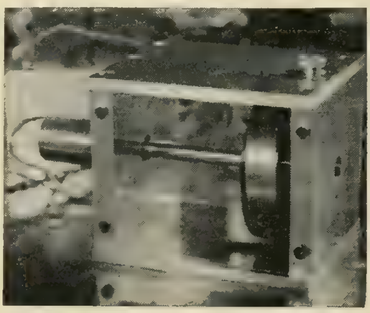
The project, headed by Dr. Nancy G. Roman, has not yet been given a name.

Unprecedented orientation accuracy will enable the vehicle to maintain position indefinitely within 1/10 second of arc. The payload will be oriented by stellar check points, instead of earth, and five separate experiments will be carried out.

NASA feels that a cost figure of $25-million for the program is "in the ball park." This does not count the boosters, and presupposes the absence of major problems. NASA would like a schedule calling for one launching per year until seven vehicles have been launched.

Experiments will include: ultraviolet stellar spectrograph (Goddard Space Flight Center); ultraviolet photometer (University of Wisconsin); ultraviolet sky mapping (Smithsonian Astrophysical Observatory); high-dispersion stellar spectrograph (Princeton University); and solar experiments (University of Michigan).

A preliminary briefing on the project, still in early development stages, was held at NASA headquarters on Dec. 1, 1959. At least 30 interested companies attended.



REACTION wheel on stable platform shown in its housing.

• **Management money**—Management of the program is presently divided among NASA and the individual experimenters. NASA makes decisions affecting the overall program or vehicle, but experimenters are free to work within their own areas. It hasn't been decided whether major system management will be in-house or in industry; most contracting, however, will go to industry.

NASA won't be able to take on major funding this fiscal year, but has money available for "small" study contracts which will not cover the entire system. Areas which may yield study contracts are: coarse orientation and slewing system; fine stabilization system; means of balancing the payload in orbit; effect of magnetic and gravitational fields; acquisition television system, and a backup system for same; and the data storage system. Contracts will be awarded on a competitive basis.

Equipment to go aboard the satellite is still being developed; preliminary objectives call for a number of telescopes; a television system which can resolve 6th-magnitude stars to ½-

magnitude, with 500-line per-inch resolution or more; and storage capacity for data acquired. The telescopes will be six to eight feet long, probably with a 32-in. diameter primary mirror —although 36 in. is desired. Backup will be provided only where such a move would enhance reliability.

• **The drill**—The vehicle will need analog data, digital data, and TV data, as well as some 30 command channels. The sequence to be followed during operation: Immediately after injection into orbit, the payload's sun-seeker orients the satellite with the sun, with horizon scanners controlling the other two axes. A television camera with suitable optics (covering a 10x10-degree field of view) transmits a picture to an astronomer at a ground control station.

The ground control operator then orients the satellite in accordance with the displayed information, and sets it toward a target star to be examined. When close to this star, the automatic tracking mode takes over, and the remaining operation is automatic, its program depending on the current experiment. It is unlikely that two experiments will be in process simultaneously; they will probably operate on a time-sharing basis.

The payload will be programmed so that, except in the solar experiment, the instrumentation will look no closer than within 45 degrees of the sun. The remaining experiments are calibrated for much less light. Because of this inability to look toward the sun, it will probably take about one year to map the entire sky.

The orbit, which will be inclined about 35 to 40 degrees, was chosen to get above significant drag, while remaining below the Van Allen belt. Ground control will be by the Minitrack system.

• **Control alternatives**—Three control modes will be incorporated into the satellite's system: acquisition; coarse control (accurate to one minute of arc); and fine control, or pointing. NASA has not specified which attitude control system it will use, saying it will leave this open to contractor suggestions. One method is reaction wheel control, with a motor driving the flywheel and thereby producing an equal torque on the vehicle.

Another way to accomplish the purpose is to use a gyroscope whose flywheel turns at a constant speed, so that a torque is produced by changing the spin axis of the gyro. Both these momentum-transfer schemes demand some way of getting rid of the momentum that is stored on the controls. This might be done with a solar sail or a sliding weight designed to dissipate the angular momentum.

A third system being considered is vapor jets operating at low pressure; a variation would be high-pressure jets —which might also be valuable in initial stabilization of the vehicle after orbital injection.

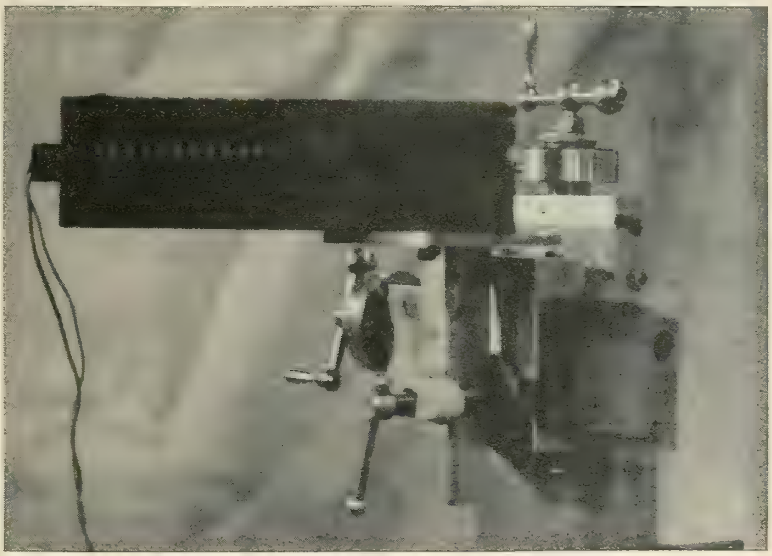
• **Progress in accuracy**—Preliminary work on attitude control is being done at NASA's Ames Research Center, responsible for research on various engineering aspects of the program. The center is developing extremely-low friction air-bearing platforms for studies of problems involved.

Experimental equipment used at Ames includes a stable platform utilizing 30-psi air supply to support the 200-lb. table, on which are mounted control devices. Among these are a telescope with error detectors and photodetectors. An artificial light source simulates a star, and corrective action of the control system is checked in orienting the table.

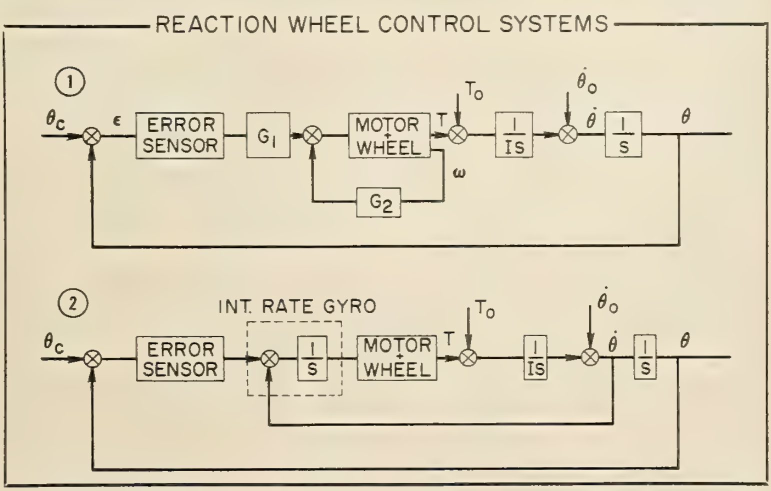
Accuracies to one second of arc have already been achieved; it is anticipated that this will improve to the necessary 1/10 second. Since the satellite will have to have accuracy over one order-of-magnitude more precise than present earth-oriented satellites, the perfected system will represent considerable progress.

How long the satellite will be required to maintain a set position in orbit will vary with the experiment being conducted; it will range between a few minutes and an hour.

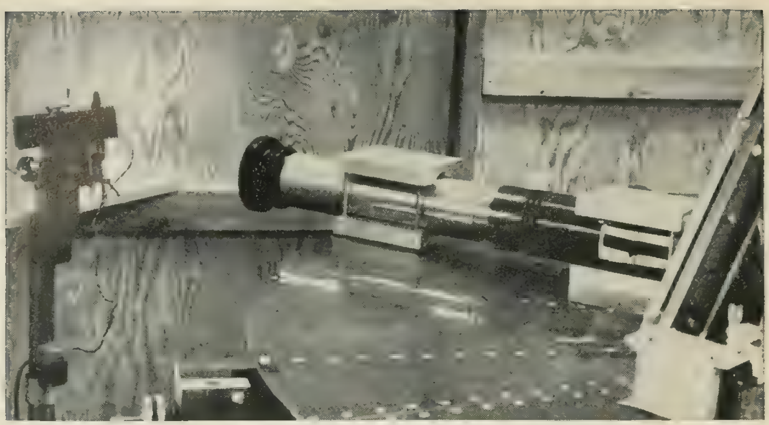
• **Exquisite reliability demand**—The problem will be reliability. Robert M. Crane, Chief of the Aero-Thermodynamics Division at Ames, says, "We have an extremely complex control system, communications system, and experiment system—and we're asking all



ARTIFICIAL LIGHT source equipment for NASA astronomical satellite.




SPACE STATIO
PROJECT ARGUS



TELESCOPE ON stable platform sights toward artificial light source to orient platform. In left foreground is balance adjustment for the platform. Plywood structure surrounding platform was built by NASA solely to prevent random air currents in laboratory from disturbing experiment.

of them to work unattended for twelve months."

Power supply for the vehicle, yet to be established, will probably consist of solar cells and storage batteries. A nuclear power source has been considered, but this might have adverse effects on the instruments.

Some unique problems have arisen regarding thermal balance. Optical devices, photocells, photo detectors, and other equipment must be kept cool; storage batteries and other electronic equipment must be kept warm, and solar cells for recharging storage batteries must be kept cold. Optical devices may go out of focus during thermal change, but this may be combated either by providing a re-focusing capability or by using materials which are not drastically affected. The latter is considered the most likely solution.

• **Ultraviolet spectrograph**—The ultraviolet stellar spectrograph experiment is expected to get absolute-energy distributions of stars in the wavelength regions from 4000 to 1000 angstroms, and also to obtain spectra, on an absolute basis, of emission nebulae which occur in the sky and galaxies.

The telescope used in this experiment will consist of a 32-36-in. mirror operating around f/1, and a secondary mirror which will put a return beam through the hole in the primary mirror of about f/5. The light will pass through a diaphragm on the collimating mirror, back into the telescope, on to a large grating, thence to a camera and a detector system.

Objective of the experiment is in photometry more than in high resolution; the spectral resolution will vary from one angstrom to about 50 angstroms. The detection system will consist of one or more photomultipliers, each having a slit before it and covering a certain wavelength hand. The grating (15,000 lines and 10 in. across) will be rotated in finite steps approximately every 20 seconds. The field of view will be about 3 seconds of arc.

Two channels of telemetry are expected to handle data from the experiment, and core memory will likely be used. The feeling is that tape-recorder moving parts would give rise to torque and other problems in the delicate balance and stability required of the satellite.

It will probably take between five and 20 minutes to look at a celestial object and obtain all necessary data on it.

• **Ultraviolet photometry**—The experiment on ultraviolet photometry will measure radiation from stellar objects and from interstellar gas in a restricted wavelength region. Scientists hope to get a clearer picture of the energy distributions in stars and of the intensities of emission lines in gaseous nebulae. Typical of the data sought are the number of ergs per second per square centimeter per angstrom incident on the outside of the earth's atmosphere from a stellar source.

Instrumentation will consist of four mirrors, the focus of each directed off to the side through diaphragms and filters to a small mirror with a field lens, projecting an image of the telescope objective onto a photomultiplier. Both the diaphragms and filters could be changed. The system would include acquisition of the star and data-gathering capabilities.

Continuous transmission of data is desired during the experiment, so that ground stations will know immediately when a star is acquired.

• **Updating charts**—Sky mapping experiments will gather similar data as the previous two cited, that is, spectral intensity distribution of stars and interstellar matter. Observations will be made of the 10 million stars brighter than magnitude 15 photographic (roughly 10,000 times fainter than can be seen with the naked eye).

The objective is to establish the existence of as many stars as possible, and get available data on them. Time considerations prevent use of diaphragms or photocells, television will probably be used. The TV system

Vehicle Requirements

Moment of Inertia—800 Slug-Ft^2
Weight—3500 Lb

I. Initial Stabilization
1. Initial Vehicle Rate—1 °/Sec
2. Final Vehicle Rate—.002 °/Sec
3. Solar Orientation—±1°

II. Remote Control (TV)
1. Max. Slewing Rate—180° in 5 Min.
2. Pointing Accuracy—±15 Min.

III. Automatic Control

	Course	Fine
1. Initial Pointing Error	±30′	±2′
2. Final Pointing Error	±1′	±0.1″
3. Initial Vehicle Rate	.002°/Sec	.002°/Sec
4. External Torques	100 Dyne-CM	100 Dyne-CM
5. Max. Bias Error	——	±0.05″
6. Saturation Time	——	100 Min.
7. Angular Momentum	2.1x10^8 C.G.S.	6.0 x 10^5 C.G.S.

Engineering Aspects

I. Attitude Control
1. Systems Concepts
   (a) Reaction Wheel
   (b) Gyro Wheel
   (c) Vapor-Jet
   (d) Cold-Gas Jet
2. Error Sensors
   (1) Television
   (2) Solar Trackers
   (3) Star Trackers
3. External Disturbance Torque
4. Dissipation of Angular Momentum

II. Power Systems
1. Solar Array
2. Power Storage

III. Thermal Balance

IV. Communications
1. Command Systems
2. Data Acquisition & Storage
3. Data Transmission

V. Vehicle Layout

Systems Evaluation

1. Dynamic Performance
2. Power Required
3. Weight
4. Reliability
5. Complexity
6. Longevity
7. Availability

would be live, and controlled from the ground when within view of the control station. This would constitute something on the order of 10% of the time in orbit. The remaining time would not be actively used for this experiment and as little power as possible will be expended.

With this method, a scanning rate of one frame per second and a 150 kc band path would be needed to transmit data to the ground. No satellite storage is contemplated, but ground storage will be utilized.

(No firm choice has been made as to power supplies for all the experiments; the effect of a nuclear power package upon the experimental instruments will determine whether this possible source is chosen.)

There are no plans to try to recover any data capsules or other portions of the satellite, because such efforts would involve changing the orbit of the vehicle or changing its balance. The former would destroy its future usefulness; the latter would make it extremely difficult to carry out additional experiments due to inability to rebalance the payload to within a part of 10^3 or 10^4.

• **Gases between stars**—The high dispersion stellar spectrograph experiment will be aimed at investigation of the dark gaseous matter existing between stars. Methods of doing this are difficult, because of the dark nature of these gaseous clouds. Examination of a very hot, bright star will yield data, however, because of the effect of the gas clouds on the starlight. Such gas clouds have considerable effect, but it is restricted to very narrow wavelength regions.

Hence, it is necessary to resolve the spectrum well enough to see such an effect. It is expected that lines with a width of a tenth of an angstrom will be measured.

Equipment will consist of a 24-in. light collector aperture with a ratio of f/3. A secondary mirror, Cassegrain secondary, will change the overall ratio of f/20. Light is brought to focus at a point on a slit with a spectrograph, the entrance slit of the spectrograph being five microns wide. Located roughly in the center will be a concave grating, which will be struck by light and form the spectrum along the edge of a Rowland circle. Along the edge of this, behind exit slits of the same five-micron width, will be a series of photo tubes.

This experiment is the one which demands accuracy of 0.1 second of arc for an indefinite period of orientation accuracy.

• **Look at the sun**—Solar experiments will examine small areas on the surface of the sun, such areas having a maximum size of one square minute of arc. Both quiet areas of the disc and various disturbed areas will be studied.

Equipment will be a large spectrograph with a small collecting surface. Diameters of the collecting mirrors will be on the order of an inch or two, except for the far ultraviolet and X-ray regions. Three grating spectrometers will cover sections of the spectrum from 3000 to possibly 75 angstroms. Each will have a photomultiplier output.

In addition to these three instruments, a spectroheliometer will be set on Lyman-alpha line of hydrogen at 1216 angstroms. An image of the sun will be produced in this radiation and will be monitored by vidicon, either by command or storage. Smaller instruments may be included to cover X-ray and other areas, as well as possibly a second TV camera to photograph the sun in other wavelengths.

New Space Tracking Proposed by ACF

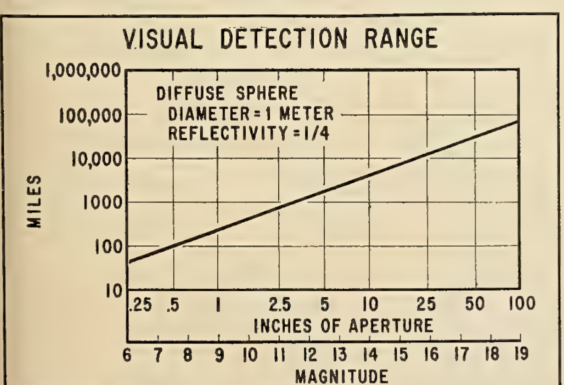
by Charles D. LaFond

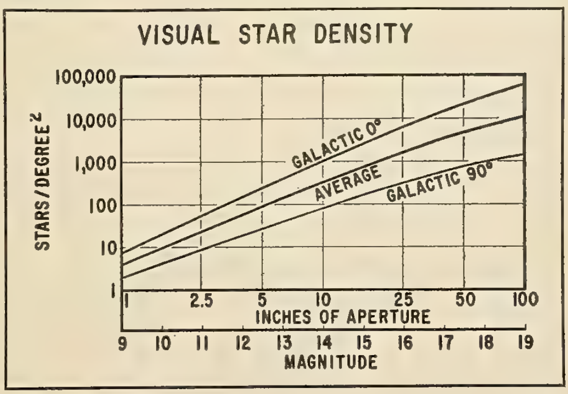
The color difference between activated and recently vacated spots on a radar screen can be used to discriminate moving from fixed targets over short time intervals, according to ACF Electronics of Paramus, N.J.

Use of this phenomena has been proposed by Harvey Dubner, manager of the division's Advanced Development Laboratory, for the development of a very sensitive "Celestial Moving Target Indicator."

A technique could be used, said Dubner, to supply an electrical processing analog to the current procedure of comparing photographs of the same sky area to detect movements of luminous objects. This standard technique of astronomers is quite satisfactory over long time intervals, but is impractical in missile or satellite applications where very short observation intervals are often necessary.

By employing only today's components, Dubner believes a satisfactory CMTI with a 30° field of view could be produced. The proposal is based on a characteristic of the P-7 phosphor screen, used in most radar systems and long-persistence oscilloscopes. For a continuously activated spot, the phosphor fluoresces blue-white; a recently vacated spot phosphoresces yellow. Fixed stars, therefore, appear blue-white while moving targets leave a yellow trail. It is this color difference





that could be used.

In operation, the sky field is imaged onto a beam intensifier whose output appears on a P-7 phosphor screen. The resulting light output is viewed with a two-color television-type orthicon which gives a signal for blue separate from that of the yellow. Since the blue-white fluorescence consists of blue and yellow components, while the phosphorescence contains only yellow, subtraction of these signals can be made to yield a signal representing only the moving sources.

The moving source signal may then be recombined with the blue or star-reference signal for presentation on a storage-type cathode-ray receiver. Ideally, the receiver would be two-color. The combined signal also would be available for use in an orbit or impact-point computer.

• **Varied applications**—Although this technique is particularly applicable to orbiting satellites, it can also be used for tracking rockets during their boost phase and for missiles carrying flash bombs, said Dubner. The system can be operated to plot a single moving target path or a multitude of moving target paths. While maximum potential is obtained at orbital elevation points, this system can be operated successfully from the surface of the earth. Range capability is of the order of thousands of miles.

Figure 1 shows the visual detection ranges obtained with telescope apertures of varying sizes from a one-meter sphere. The sphere is assumed to be approximately half-illuminated by the sun and to have a reflectivity of one-half (net reflectivity is 25%). Ranges are calculated on the basis that the eye can just perceive an object when it receives 16,000 photons per second (sun spectrum).

Figure 2 shows the density of visually detectable stars as a function of telescope aperture. (A scale of stellar magnitude is also included.) Even for telescopes of moderate size, star density is high.

It might be expected that some help could be obtained by using spectral discrimination, but this is not true, according to Dubner. If the total integrated intensity of all the stars as received at a detector is analyzed, he said, it is found to correspond closely to a temperature of 5800° K or to a spectral distribution very similar to that of our sun. Because of this, reliable spectral discrimination appears impossible between a source based on reflected sunlight and the star background.

Figure 3 shows star density as a function of detection range for the one meter sphere.

• **Screen characteristics**—The P-7 phosphor is a two-layer screen widely

←Circle No. 10 on Subscriber Service Card.

used for radar application. During excitation by an electron beam, the phosphor produces a bluish-white fluorescence of short persistence of the order of 10^{-5} seconds.

After excitation, the phosphorescent light output is constant for a time $T_0 = 3 \times 10^{-4}$ seconds and then falls off inversely with time. The color is greenish-yellow. A wrattan No. 12 filter can be used as a dichroic reflector and provides a maximum discrimination between the short persistence fluorescence and long persistence phosphorescence.

• **Detector characteristics**—The light from the moving source and star background is collected by the optics and focused on the sensitive surface of the image intensifier, the final stage of which is the P-7 phosphor. Spectral response of the photo-surface must be matched as closely as possible to the sun spectrum.

A tri-alkali photo-surface is the most sensitive photo-emitter presently available, and its peak response is very close to that of the sun. The noise equivalent power per resolution element is 320 solar photons per second.

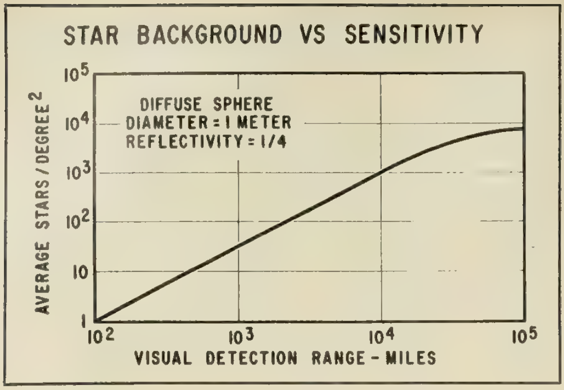
• **Background level**—The CMTI technique discriminates against fixed targets, but, for the moving target to be detectable, energy received must exceed normal background level of radiation.

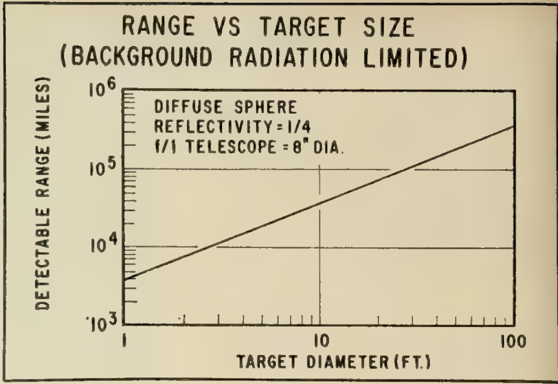
The total star energy received at the top of our atmosphere is approximately 9.6×10^{-11} watts/cm²/steradian. Most of this energy is resolvable as points and can be discriminated against. The portion of the energy from very dim stars forms a background level of radiation which the moving target must exceed by a reasonable factor.

For example, 82% of received stellar energy comes from stars brighter than 16th magnitude. For an 8-in. optical system with a resolution of 0.5 milliradian, consideration of star density, resolution, and energy distribution indicates that approximately 15% of the total star energy is distributed in what could be considered a random manner. The background thus is approximately 5000 solar photons per second per resolution element, which is considerably higher than the dark noise equivalent power.

Assuming a threshold signal-to-background level of 5, detection range of the CMTI system can be computed. Figure 4 shows range plotted as a function of target size.

• **Star twinkle**—The CMTI technique is based on the different spectral outputs from a P-7 phosphor for a steady activation compared to a temporary activation. The effect of star twinkle may degrade the efficiency for





discrimination because the steady star source is replaced by a fluctuating source. The degradation depends on the amount of modulation introduced by the twinkle. Principle characteristics of star twinkle are (1) brightness fluctuations, (2) lateral movement of the image (giving rise to a shimmer disc, a luminous disc in place of an image spot), and (3) changes in image color.

Since the physical phenomena that cause these characteristics are based on diffraction and refraction effects, brightness fluctuations also are attributed to diffraction effects. They develop from the interaction of the light with small turbulent irregularities. Shimmer discs are said to be due to refraction of light by relatively large turbulent areas.

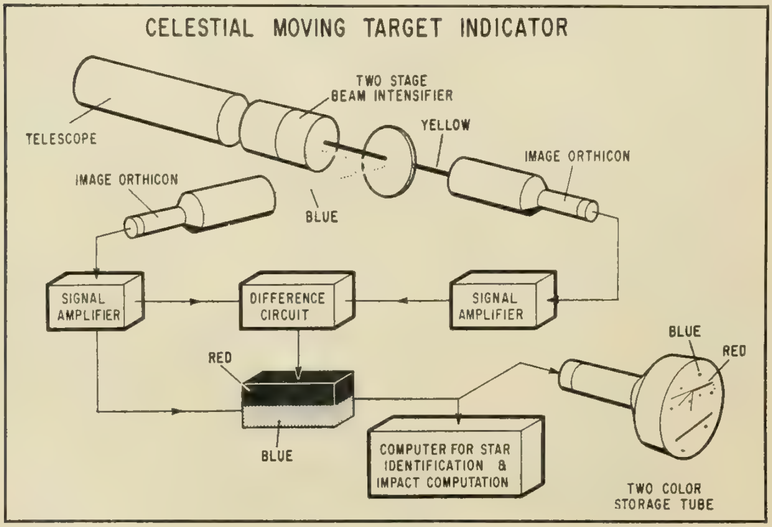
The color phenomena appears to be a combination of these effects. It has been found that the frequency and amplitude of the brightness fluctuations depend on the aperture and the zenith angle at which the telescope is oriented. When the fluctuations are Fourier-analyzed, frequencies are below 100 cps, with the majority grouped at lower frequencies.

For the system parameters considered, preliminary calculations indicate very little degradation due to star twinkle. If necessary, twinkle effect could be reduced by high altitude operation, use of large aperture telescopes, and fast signal processing.

• **Low-velocity limitations**—As the angular rate of the target decreases, the effective intensity of the long persistence phosphor also decreases.

If the elemental resolution area just vacated by the moving target is observed, the average intensity of the area appears to be less with a slow target than with a fast target. The effective reduction in intensity is a function of the focal length and resolution of the optical system, the velocity of the target, the range of target and the long persistence characteristics of the phosphor.

The velocity limitation seriously degrades the CMTI system performance and is directly traceable to the characteristics of the phosphor. The most serious single degrading factor is the persistence characteristic of the P-7 phosphor. Development of a special phosphor more suited for this application would extend the range capability from the order of thousands of miles to tens-of-thousands of miles. It is in this direction that ACF believes the next development stage should now proceed.



EIA Seminar to Discuss 'More Bang per Buck'

"More Defense per Dollar" will be the theme of an Electronic Industries Association seminar set for March 15 in Washington. Panel sessions will bring together 13 top defense planners in government and industry to evaluate defense planning to date and investigate ways to shorten the gap between weapons system conception and hardware delivery.

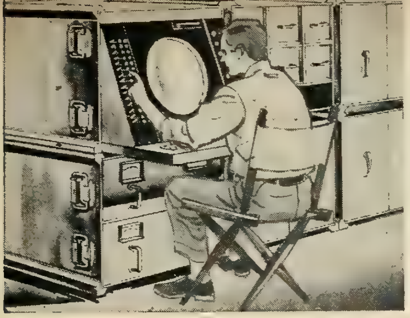
The military panel will be chaired by Sidney Curtis, senior vice president of Stromberg-Carlson. Members will be representatives from the Navy, Army Signal Corps, Air Force's Air Research and Development Command, and Defense Department research and engineering.

Vice Adm. John H. Sides will chair the industry panel. Top planning and marketing personnel from Lockheed, General Electric, Hughes Aircraft, and RCA will serve as panel members.

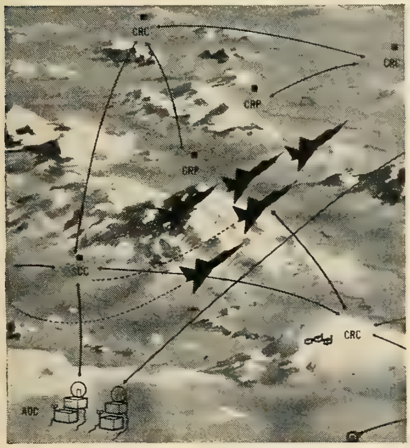
Approximately 150 DOD representatives with major responsibilities in planning have been invited to the seminar. Several hundred from industry are expected to attend.

John M. Sprague, Deputy Assistant Defense Secretary, will speak on "Fiscal Operations and Military Planning" at the seminar luncheon. Rep. Gerald Ford, Jr. (R-Mich.), ranking member of the House Armed Services Appropriations Committee, will address the dinner meeting on "Congressional Responsibility in Defense Planning."

The marketing seminar will be the opening feature of the EIA Spring Conference.



A Tracking Center collects, evaluates and displays pertinent information on all air activities within its area of responsibility. Each tracking site can track while scanning many high speed maneuvering targets. Position information and supplementary intelligence is available for insertion into the system from the communications network which involves all stations in the system.



The Control Function results in accomplishment of tactical air missions assigned by the command center, including intercepting air targets, air attacks on ground targets, return-to-base missions and response to emergency situations. The vectoring computer group calculates optimum intercept vectors, and guides the assigned aircraft to the target, constantly correcting for target maneuvers and drift. One air controller can monitor many air missions, providing a greatly expanded capacity over manual systems.

Communication is accomplished in ground-to-air messages by automatic voice or digital techniques. Microwaves, tropospheric scatter or land line communication is used between sites. Compact message structure and efficiently programmed time-sharing insures rapid updating of a maximum number of targets. Communication facilities are flexible and can easily be reorganized to accommodate a change in the number of sites.

From the REMINGTON RAND UNIVAC

Military Division

TACS—combining data processing, communications and control functions—demonstrates total systems capabilities.

A significant example of the capabilities of the Remington Rand Univac Military Division is the AN/TSQ-13 Tactical Air Control System. This USAF System automatically performs air surveillance, evaluation and control functions in a 160,000 square mile area, reassessing the air situation every 30 seconds to facilitate command decisions.

The transportability of the System allows Control and Reporting Centers to be quickly moved into far forward positions to give surveillance of tactical territory. A communications network, involving both voice and digital techniques, coordinates these functions with weapon groups and other military activities to successfully meet the fast-changing needs of the tactical air situation.

Designed and built by the Military Division, the Tactical Air Control System fully integrates the computation, communication and control functions. The System represents a solution to a complex problem and exhibits the characteristics which have become identified with Remington Rand Univac achievements in the military area—compact size, high speed of operation and reliability under demanding environmental conditions.

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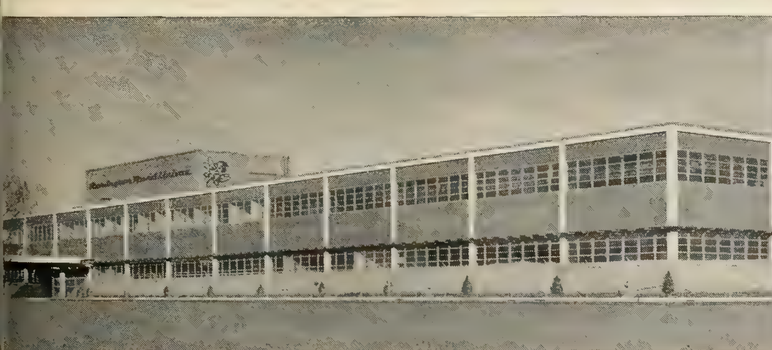

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Other control and data systems developed by the Remington Rand Univac Military Division include:

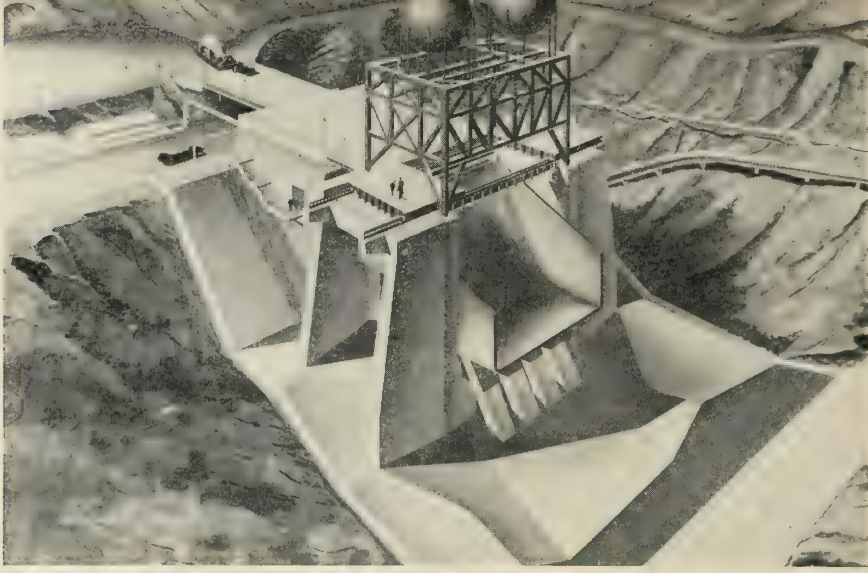
ATHENA, the Ground Guidance Computer for the U.S. Air Force ICBM TITAN.

BOMARC Computer for the U. S. Air Force Target Intercept Program.

SEA SURVEILLANCE SYSTEM FOR THE U. S. NAVY

AN/USQ-20 (Advanced Computer for the U. S. Navy).

Additional information describing capabilities and experience or career opportunities may be obtained by writing to Remington Rand Univac at the above address.



WHEN FINISHED, Rocketdyne's 1.5-million-lb.-thrust test stand at Edwards AFB will look like this. Engineers of Aerojet-General's Aetron Division who designed the stand, say it should ultimately accommodate 6 million lbs.

ground support equipment

Concrete Being Poured for F-1 Stand

Pouring of massive footings to anchor the static test stand for the nation's first 1.5-million-lb.-thrust single-chamber F-1 rocket booster is now under way at Edwards AFB, Calif.

The 230-ft.-high stand is expected to be finished late this year. Static firings will commence in early 1961. It is being built into the side of Leuhman Ridge, a granite cliff already studded with Air Force test stands that overlooks the Mojave Desert.

Cost of the 1-B test stand, two smaller test stands and a central control bunker for this NASA complex will total an estimated $12 million.

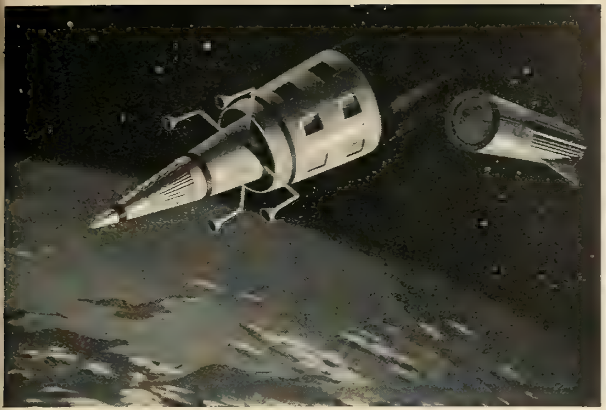
The 1-B's foundation will require 12,000 yards of concrete, enough for a good-sided dam or a mile of eight-lane freeway. The stand will have a steel flame deflector weighing 260 tons. It will be water-cooled with 60,000-gal.-per-min. spray system. A small lake at the bottom will capture the excess for recycling.

Two stainless steel spheres sitting atop the reinforced girder framework will hold the fuel and oxidizer. The F-1's turbopump will deliver fuel at the rate of about three tons per second during mainstage operation.

Design of the foundation structure was by Aetron, a Division of Aerojet General. The Army Corps of Engineers is supervising construction,

ENGINEERS inspect thrust mount for F-1 test facility.

THESE HIGH-PRESSURE gas containers will be used in testing NASA's F-1, or *Nova* vehicle, rocket engine. Tanks service Stand 2-A at Edwards.

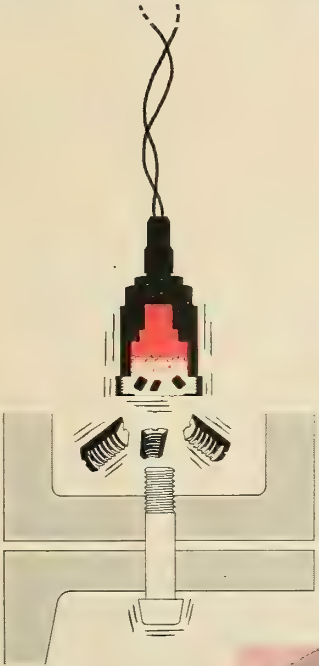


TYPICAL APPLICATIONS

- SEPARATION OF MULTI-STAGE VEHICLES AND NOSE CONES.
- RELEASE FROM LAUNCHING PADS.
- RELEASE OF BOOST ROCKETS AND LAUNCHING SLEDS.
- RELEASE OF TANKS AND JETTISONABLE ITEMS.

FOR SEPARATION SYSTEMS THE NEW

SEPARATION NUT



A unique, safer and more efficient method for separation systems is offered by the Separation Nut.

The Separation Nut is unique because its controlled separation is a highly reliable mechanical function activated by a very small explosive charge.

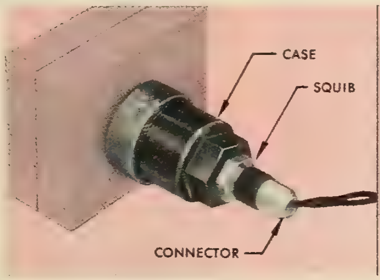
By using the Nut's small explosive charge rather than the "brute force" explosive techniques so commonly used to fail high strength material in explosive bolts, the Separation Nut can substantially reduce a potentially hazardous condition to installation crews and to the vehicle itself.

More compact joints can be designed since Separation Nuts are used in combination with standard diameter, high strength bolts used at full allowables.

Separation Nuts reflect another new fastening concept developed in Hi-Shear's specialized engineering and laboratory test facilities for the specific needs of space vehicles and high performance aircraft.

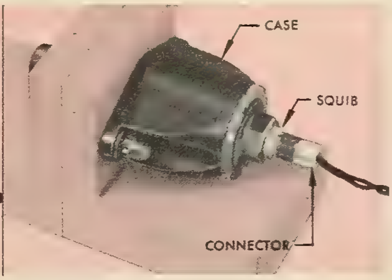
Write for brochure . . . describes how the Nut works, high speed photos, design goals, typical applications and summary of the test program.

PATENT APPLIED FOR.



NON-CAPTIVE NUT

Basic configuration . . . accommodates bolt thread sizes including 1/4-28 thru 3/4-16.



CAPTIVE NUT

Because only a low explosive charge is used, all fragments can be easily contained by Nut's case. A similar case can arrest a bolt after detonation.

hi-shear RIVET TOOL COMPANY

2600 WEST 247TH STREET • TORRANCE • CALIFORNIA

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which is under contract to Del E. Webb Construction Co. The Rocketdyne Division of North American Aviation, prime contractor for the F-1 engine, is in charge of the overall design and construction of the complex.

• **Thirty-degree firing**—A two-position thrust chamber testing facility being built on the opposite side of the ridge is almost finished. Here, at test stand 2-A, the F-1 thrust chambers minus their pumping mechanism will be fired at a 30-degree angle.

Propellants will be delivered under high pressure from 6-in. steel spheres through 14-in. lines. Contractors for this site include the Ralph M. Parsons Co., Mid Valley Utility Constructors, Alex Robertson, Southwest Welding & Mfg., and Chicago Bridge and Iron.

Near this site, a former *Atlas* engine stand has been torn down to its foundation and is now being rebuilt to hold the F-1 engine mount structure. From this 1-A stand the big space engine will be fired 130 ft. downward into a water-cooled deflector. Principal contractors are Kaiser Steel, Southwest Welding and John A. Minasian, a structural steel consultant.

All of the foundations are government-funded. Rocketdyne, as part of its overall $102-million contract, is changing $5.5 million for the superstructure and control equipment, according to a recent Government Accounting Office report.

A shortage of steel caused by the steel strike, NASA officials say, has delayed construction of the stands in certain areas. Actual dates when the stands are to be used have not been disclosed. However, Rocketdyne expects to put the smaller 1-A and 2-A stands into use this year.

Design of the turbopump with a 3-ton per sec. capacity is still being proven out in tests of model parts. A full-scale F-1 mockup using a full-scale, uncooled combustion chamber has already achieved completely stable combustion at more than 1 million lbs. thrust, according to NASA.

Minuteman Silo Tests Winding Up

BMD completing one-third scale model firings in improvised Edwards facilities

A three-year-old program to develop a hardened underground silo for launching the *Minuteman* ICBM is approaching its final stage at Edwards AFB, Calif.

Some time soon—Air Force Ballistic Missile Division's exact schedule is classified—designs will be established for a few variations of procedures and configurations to be tested in a series of full-scale tests, which will set the guidelines for launch facilities at Cape Canaveral.

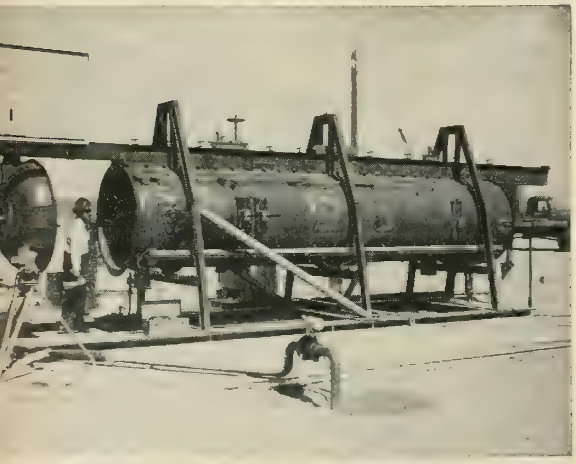
Preparatory to the full-scale testing, a series of about 25 one-third scale firings has been under way for more than a year. The one-third scale tests were designed to provide data on basic configuration, effects of missile emergence, flame detector design, silo depth and diameter, canted nozzles, silo liners and support structures without going to the expense of a lengthy series of full-scale tests.

Of the many designs originally considered, only a few variations will appear in the full-scale tests, which will use the first full-sized *Minutemen* built.

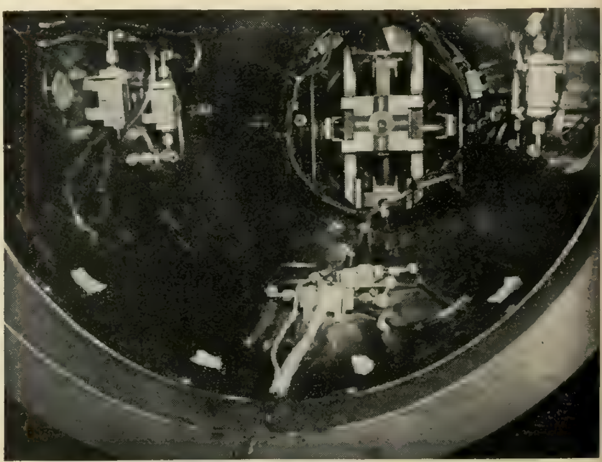
• **Silo development laid out**—AFBMD laid out the silo development program in 1957, when only a few large rockets had been fired and there was but meager data on the effects of a large rocket fired from an underground facility.

The Silo Launcher Development Program at Edwards was given a free hand except for one restriction: cost was to be kept to a minimum. The first launch from a silo took place at Edwards in March 1958. A 4000-lb. rocket borrowed from the rocket sled test program was modified and fired from the bottom of a pipe 24 in. wide and 12 ft. deep.

• **The first tests**—After a few such exploratory shots, a series of tests was begun in October 1958 with a solid-



SIMULATED SILO, or tube in which scaled-down *Minuteman* test program is conducted. At left is one of the deflector plates being studied.



INTERIOR OF horizontal test silo, showing some of the instrumentation connections. Overhead track is at top; back shows braces for vehicle.

propellant air-to-air rocket, 2.75 in. in diameter, held captive inside a plastic tube. A layer of fine mesh wire furnished the first data on how firing would affect the missile and silo configuration. By June 1959, 213 such rockets were fired, yielding a great deal of data on the effects of silo diameter and primary flame deflector shape on heating of the missile within the silo.

Next, the rockets were tested at 1/20 scale—a diameter of 3.25 in. in the first stage—by the Boeing Airplane Co., which had been chosen in the meantime as a major associate contractor for *Minuteman* assembly and test. Boeing ran more than 1200 tests of aerodynamic effects, using compressed nitrogen. The "cold flow" tests were found consistent with the "hot" tests. AFBMD and Space Technology Laboratories then decided on the series of one-third scale tests. The first took place Feb. 17, 1959.

The "Third" tests take measurements of pressure, temperature, acoustical environment, vibration, thermal radiation and amount of strain registered at various points by load cells. Fed into a computer, these measurements provide answers to the prime questions. For information on the effects of missile position changes, data are collected on heat transfer, missile frame stresses, acoustical environment and the initial shock wave in the silo.

The facility consists of a horizontal test silo of AIS 1020 steel plate ¼ in. thick. One end is closed by a movable steel flame deflector plate ¾ to 1½ in. thick, depending on test objectives. The tube is anchored by steel girders in a concrete pad 33 x 58 ft.

From the open end of the silo, an overhead metal track runs into a laboratory van parked at the edge of the concrete. Supporting hangers along the track make it possible to move the test missile into the silo. The deflector also hangs from the track.

Six holes ½ in. in diameter around the center of the deflector are inlets through which 240 gallons of water a minute is sprayed into the silo at burnout at 150 psig pressure.

An M-47 Army tank, rendered immobile and heavily modified, standing behind a bunker 200 ft. away, is the blockhouse and control center. Some controls and communications facilities are in three nearby vans.

The test missiles will carry a cluster of four Atlantic Research Corp. solid rockets in the booster stage, inside a ¼ in. skin—considerably thicker than in the actual *Minuteman*. Second and third stages have the same shape and general configuration as the real missile but are filled with instruments rather than propellant.

During slightly more than three seconds of firing, over 140 measurements are transmitted to equipment in the vans, most of which was designed and initiated by Stavid Engineering.

Maj. Rex Gray of the AFBMD Field Office at Edwards is in charge of the Third tests.

AC Spark Plug Opens R&D Facility on Coast

EL SEGUNDO, CALIF.—Plans to use the Air Force *Titan* ICBM as a space booster for lunar and Martian probes were revealed here last week as AC Spark Plug Division of General Motors opened a new research laboratory.

The company said the new facility, Advanced Concepts Research and Development Laboratory, "will be investigating the complexities of missiles and space exploration with specific emphasis on the *Titan* system for use in lunar and other planetary probes, namely Mars."

Other projects to be handled by the lab include an azimuth-elevation star tracker for inertial guidance, satellite stabilization, space navigation applications and advanced digital computers.

• **Strictly R&D**—The 67,000-square-foot facility, near Los Angeles International Airport, houses electronics, optics and digital computer laboratories, and employs over 100 engineers and scientists. It will do no manufacturing, but will take a system to the point of prototype construction.

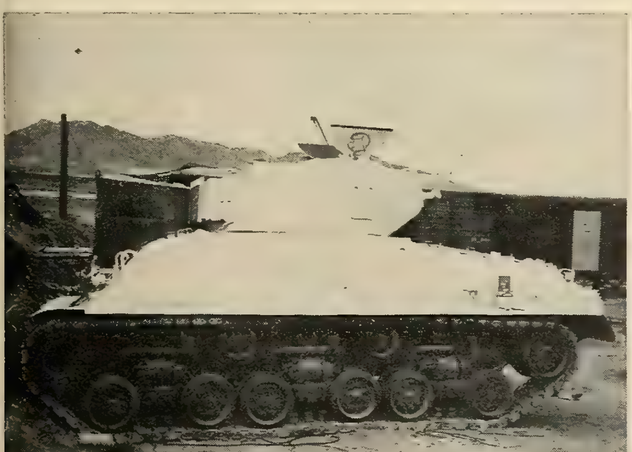
Four operating groups make up the laboratory:

• The Advanced Systems Planning Group; responsible for development of advanced guidance systems and techniques, space guidance and establishment of requirements for advanced components.

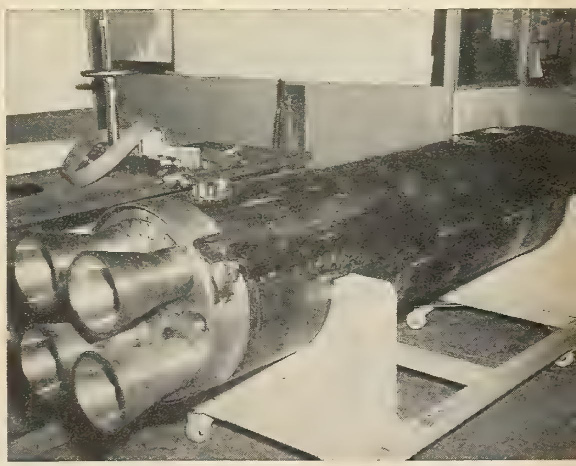
• Guidance Analysis Group; responsible for development of navigational schemes and equations, air analysis and statistical studies, and computer services.

• Design Analysis Group; responsible for dynamic analysis and analytical design of the various elements of guidance and control systems, analytical studies leading to development of advanced components and techniques, and the analog computer simulation laboratory.

• Development Laboratories Group; responsible for mechanization of complete guidance systems, development of electronic, electromechanical, and optical components, the electronic laboratory and the optical laboratory.



NOT AN ARMY TANK but it is the blockhouse for *Minuteman* test site. It's fitted with control panels, periscope, and communications equipment.



SCALED-DOWN, one-third model of *Minuteman* ICBM is readied in van for insertion in horizontal test silo at Edwards AFB, Calif.

Seals With ± Zero Tolerance

SILASTIC® RTV
SILICONE RUBBER

Forms Airtight Weather-Proof Enclosure

Aircraft and missile engineers have found an effective material for sealing airframe members and other parts. It's Silastic RTV, the Dow Corning room temperature vulcanizing silicone rubber.

In the F-102 and F-106* canopies, for example, engineers at Convair Division of General Dynamics (San Diego), specified that the windows be "floated" in Silastic RTV. This window seal maintains cockpit pressure but resists cracking and checking and other effects of weathering and ozone. It remains pliant in spite of stratospheric cold.

And Silastic RTV seals are easy to form. Semi-fluid in nature, the RTV can be applied by caulking gun directly to the spot you want sealed. In a short time (you can vary the time from a few minutes to a whole day) the fluid sets up to a rubbery solid, and you have a seal with tolerances to ± zero. Other uses of Silastic RTV, aside from caulking and sealing, include potting of electronic gear and making of molds for prototype parts. Various consistencies are available for application methods other than caulking gun. For further information on this product, send for literature: "How To Use Silastic RTV." Address Dept. 7603.

*SHOWN F-106 DELTA DART.

TYPICAL PROPERTIES OF SILASTIC RTV SYSTEMS

After Vulcanizing (24 hours at 77 F)	*Fluid Grade*	*Caulking and Putty Grade*
Hardness, Shore A	30 to 65	20 to 55
Tensile Strength, psi	250 to 850	225 to 450
Elongation, percent	100 to 250	120 to 400
Brittle Point, degrees F	−100	−178 to −100
Shrink, linear, percent		
after 3 days* at 77 F	0.6	—
after 6 days* at 77 F	0.8	1.2 to 1.6
after 14 days* at 77 F	1.1	—
Water Absorption, percent after 70 hours immersion at 212 F	1.0	1.0
Working Time	10 min. to 3 hr	2 to 5 hr

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Press Development May Speed Research

Capability of applying pressures of 1.5 million psi could open new manufacturing processes

by James A. Fusca

NEW YORK—Research in the opening field of ultrahigh pressure techniques may be facilitated, possibly leading to new manufacturing processes, with development of an ultrahigh-pressure press capable of applying pressures up to 100,000 atmospheres (1.5 million psi) at temperatures from near absolute zero to 5000°F.

The press has been developed by Engineering Supervision Company, a subsidiary of F. H. McGraw & Co.

The effects of ultrahigh pressures have been under study in research laboratories both in this country and the Soviet Union for several years with very small capacity presses. These techniques have been applied by General Electric, in a project headed by Dr. Tracy Hall, to production of small industrial diamonds. The new press, however, reportedly can be built with capacities large enough to be used in commercial manufacturing processes.

Engineering Supervision Co. believes the press offers important opportunities for investigation of:

• Improvement of physical properties of metals and other materials. For example, in experiments made by General Electric, high-speed tool steels which normally increase their grain size under heat treatment have been heat-treated while under ultrahigh pressures, with no increase in grain size. In this manner, the improvements in physical properties provided by heat treatment have been combined with the smaller grain size—equivalent to higher ductility—of the untreated state.

• Production of new metallic alloys and new chemical compounds. For instance, titanium and magnesium cannot be allowed at atmospheric pressure because the boiling point of magnesium is lower than the melting point of titanium. Alloying of the two metals is believed to be feasible, however, under ultrahigh pressures—provided the proper temperatures are generated.

• Phase transformation. The transformation of graphite into diamond is an example of this class of reactions. Methods for the production of other chemical compounds such as garnets have also been developed.

• Densification of powders. Under the present-day method of hot-pressing and sintering, powders can be densified to 90-95% of their theoretical density. With application of ultrahigh pressure, however, some powders have been densified to within 99.8% of their theoretical density.

Research has revealed that several unknown solid phases often exist under high-pressure conditions. For example, while only one phase of bismuth exists at normal atmospheric pressure, eight phases are known to exist at 120,000 atmospheres and 500°C. Therefore, the possibility of using pressure treatment to produce alloys with certain desired physical properties exists, either without or in conjunction with conventional heat treatment.

In other laboratory experiments, high pressures and temperatures have been used to form certain minerals not normally found in nature. For instance, coesite has been formed from quartz at pressures of 65,000 atmospheres and a temperature of 750°C. Another mineral formed at the same pressure but at a temperature of 1500°C is borazon.

An application of great interest in the rocket engine field, but one that lies in the indefinite future, is the theoretical possibility of creating metallic hydrogen under extremely high pressures. As a rocket engine fuel, metallic hydrogen offers a specific impulse of approximately 2500; but, in addition to other problems, its production requires presses capable of ten times the pressure of those available today.

The company has already sold seven of its newly designed presses. It also has an Air Force contract to build and operate and ultrahigh-pressure test facility in its laboratory.

Lord Damping Extends Structures' Life

The lifetime of structural materials exposed to high-intensity acoustic energy can be extended by a factor of 20 through application of a new damping development at Lord Manufacturing Co., Erie, Pa.

Designated as "Dyna-damp," the medium can reduce resonant amplification from 20-100:1 to 3-5:1, and maintain this over a temperature range from −65° to 250°F.

The medium, a special form of Lord's Broad Temperature Range (BTR) Elastomer, is incorporated into structures by lamination. Panels consist of plies of metal plates with the elastomer sandwiched between the plates and bonded to them. The three-ply laminate can be sheared, punched or used in the same manner as aluminum sheet.

The panels can be formed to some extent over a gentle radius but company spokesmen point out that special handling techniques must be employed if severe forming is contemplated.

The structural elements are also laminates. Hat and angle sections are slotted to reduce elastic stiffness and are made rigid again by sandwiching a layer of the elastomer between the slotted beam sections.

• **Adaptable**—The damped structural sections and panels may be added to existing structures or fabricated as complete damped assemblies. These sections have approximately 60% of the strength of solid aluminum, allowing integration with load-carrying structures.

Lord engineers consider the BTR elastomer damping medium an integral part of the structure. The elastomer, a direct result of several years' intensive research, is not in a viscous state in its finished form.

The firm intends to market the development either as an add-on to an existing structure, or as components manufactured to the customer's specifications to be included as part of an original design. Dyna-damp components are currently being used in the *Hawk* missile system.

U.K. Now A Lusty Electronics Rival

LONDON—The recently released verbal montage of British electronics, by the Electronic Engineering Assoc., London, reveals not only a healthy industry but a vigorous and growing competitor for the world markets.

Vehicle for this composite of accomplishment is E.E.A.'s Annual Review of 1959, a short summary highlighting various phases of the British Electronics Industry.

With a gross production output for the entire industry at approximately £475 million, total exports of capital goods are estimated to be £28 million (5.9%)—a figure that is growing steadily. Industry growth is estimated at £30 million/year, or 6.75%. [For comparison, the U.S. Electronic Industries Association provided the following figures. Gross production output for 1959—$9.3 billion; industry growth is estimated at $1.4 billion/year, or 16.5%. Business and Defense Services Administration, Commerce Dept., estimates total U.S. exports at $412 million (4.4%).]

According to BDSA, the U.S. is by far the largest single foreign market for U.K. electronic products, with Australia and Canada running second and third. U.K. exports to the U.S. exceeded the combined total of Australia and Canada during 1958 (figures are not yet available for 1959).

U.K. electronics imports from the U.S. total about half the value of its exports to this country.

While U.S. exports have dropped by nearly 5%, British exports are on the increase. Most significant drop by the U.S. is in radio communications equipment—over $20 million in the first nine months of 1959. (This has been partly offset by a 65% increase in radio and TV broadcast equipment exports.)

One particularly interesting figure in the E.E.A. report is an estimate of 10% for the average amount of annual profits currently being invested by leading U.K. firms in self-sponsored research. (The M/R staff estimates U.S. industry is ploughing back from 20-30%, but the British are carrying an unusually heavy tax burden which doesn't leave much to play with.)

• **New advances**—In describing recent major technological advancements, two items stand out in the report, but details are scanty because of security restrictions.

One is a new "distributed amplifier" capable of handling signals from 2-24 mc and requiring no tuning.

Also, a new transmitter has been developed that can "radiate two or more completely independent transmissions" simultaneously and at different frequencies.

• **Output** — The report exhibited high confidence in two of Britain's principal fields of interest—instrumentation and radar. Said the report, ". . . Britain controls a market for the supply of instruments and test equipment," exclusive of other large amounts of military-type electronic equipments sold around the world. "Airborne search radar has had particularly wide acceptance, again against considerable efforts by American companies to command some of our markets."

Maritime radars of British make are being installed at a rate of at least eight ships per working day throughout the year, according to E.E.A. "The existing orders are a fair indication of the command this country now has over international marine markets." One firm has received orders for over 1300 ship radars in one year.

Having invented it, the British seem intent on hanging onto the earnings of at least one of their many developments.

Other areas in which the British electronics industry is making itself felt are communications systems—VHF and SHF multichannel, troposcatter, fixed and mobile microwave; instruments and test equipment; radar simulators; radar early warning systems. It also appears that the industry has made gains in developing data handling systems for missile and aircraft defense.

In the field of nuclear electronics Britain is vying heavily for the world market in experimental reactors, instrumentation, test and control equipment.

Troubles Plague Russia's Tube Plant Construction

MOSCOW—Russia is having trouble getting construction machinery laborers and materials for what will be the largest tube-drawing shop in the country.

Operations for the reconstruction of the Sinarskiy Tube-Making Plant in Kamensk-Ural'skiy are being held up partly because materials were ordered from remote suppliers despite the fact that the Sverdlovsk Economic Region is able to supply them. *(Pravda, Feb. 8.)*

NAA Engineering Praised At British Meeting

LONDON—North American Aviation was praised as being foremost in the world in rocket facility engineering by two top British engineers.

Mr. L. H. B. Forster (chief engineer) and Mr. L. Breen (senior engineer) of British Oxygen Wimpey, Ltd., lauded the American firm in a lecture on problems encountered in the design of large rocket test beds at a joint meeting of the British Interplanetary Society and the Institution of Plant Engineers, Feb. 23 in London.

Choice of site, design of mountings, blast deflector construction, and techniques used in assembling and operating equipment for handling LOX and liquid nitrogen were among the subjects covered.

British Oxygen Wimpey, Ltd., is the main contractor for the construction of the rocket test facilities at Spadeadam, Cumberland.

Swiss Rocket Clustering Method Wins British Patent

LONDON—A Swiss firm, Brevets Aero-Mechaniques S.A., of Geneva, has obtained a British patent for a method of mounting clusters of small air-to-air or air-to-ground rockets.

Except for the first and last member of a cluster, each rocket supports and is supported by other rockets. The first member is supported from the aircraft or other launching structure; the last member is of course the first to be fired.

Firing then takes place successively. The holding means for each rocket is so designed that its strength is greater than the thrust exerted on it when another member of the cluster is fired.

contracts

NAVY

$3,173,820—**Collins Radio Co.**, Richardson, Tex., for design, fabrication and furnishing of eight data terminal sets.

$2,453,608—**Motorola, Inc.**, Chicago, for producing 484 all-transistor, 10-inc. radar repeaters.

$133,079—**Microwave Associates, Inc.**, Burlington, Mass., for conducting a feasibility study and investigation of the behavior of beam plasma amplifiers.

$65,487—**Electronic of Clearfield, Inc.**, Clearfield, Pa., for oscilloscopes.

$48,000—**Avien, Inc.**, Woodside, N.Y., for temperature and shock monitor controller systems for use on the *Polaris* missile.

MISCELLANEOUS

$335,000—**The Martin Co.**, Baltimore, for developing a mathematical method of predicting what the major effects will be on a small nuclear reactor as changes are made in the size, shape and content of its fuel core.

AIR FORCE

Sigma Electronics Research Corp., Seattle, Wash., for design, test and manufacture of telemetry VSWR monitors for the *Minuteman*. Amount not disclosed.

$37,126,810—**Hughes Aircraft Co.**, Culver City, Calif., for *Falcon* missile warhead case; missile shipping and storage container; spare parts and data. Two contracts.

$2,400,000—**Hughes Aircraft Corp.**, Culver City, Calif., for continuation of development, testing and reports on fire control system and *GAR-9* missile.

$1,400,000—**Bell Aircraft Corp.**, Buffalo, for development of manufacturing methods to produce an insulated double-wall type cooled structure which would enable space vehicles to survive the severe high temperatures generated when re-entering the earth's atmosphere.

$800,000—**General Electric Co.**, Syracuse, for precision trajectory measurement system and supporting equipment.

$217,661—**Aerojet-General Corp.**, Azusa, Calif., for design, development and fabrication of five *Astrobee 200* sounding rockets.

$200,000—**Paul-Munroe Co.**, Bell Gardens, Calif., for the building of specialized hydraulic ground support equipment to be used at *Atlas* missile launching sites. Subcontract by Western Gear Corp.

$191,333—**Polytechnic Institute of Brooklyn, N.Y.**, for continuation of research on "Plasmas and High Density Beams."

$116,000—**Space Electronics Corp.**, Glendale, Calif., for studies and experiments in subsurface propagation of electromagnetic waves.

$84,867—**Electromagnetic Research Corp.**, Washington, D.C., for research directed toward a determination of characteristics of atmospheric plasmas.

$63,424—**Bell & Howell Co.**, Chicago, for motion picture cameras with various accessories, 100.

$50,000—**Sperry-Rand Corp.**, Phoenix, Ariz., for microwave command guidance system operation and support.

$49,883—**Wold Research and Development Corp.**, Boston, for research on correlation type data processing systems.

$49,612—**Stanford Research Institute**, Menlo Park, Calif., for development of improved methods to analyze meteorological data.

$49,006—**AeroChem Research Laboratories, Inc.**, Princeton, N.J., for continuation of research on "Chemical and Aerodynamic Studies in a Low Density Atomic and Ionic Wind Tunnel."

$46,988—**Aerojet-General Corp.**, Azusa, Calif., for IR tracking electronics system.

$45,660—**Boeing Airplane Co.**, Seattle, for photographic reproduction and photolithographic negatives applicable to *IM-992* missile.

$35,000—**University of Chicago**, for research relating to molecular structure by means of high-resolution spectroscopy primarily in the vacuum ultraviolet region.

$33,864—**General Electric Co., Research Laboratories**, Schenectady, N.Y., for services and material necessary to monitor a moon-reflected signal.

$31,470—**Ampex Data Products Co.**, Los Angeles, for recorder to be used in support of the *WS-133A* program.

$29,800—**Northrop Corp.**, Hawthorne, Calif., for copy suitable for photographic reproduction and photolithographic negatives in support of *SM-62A* missile.

$25,396—**American Science and Engineering, Inc.**, Cambridge, Mass., for research directed toward the study of radiation from the moon.

$22,000—**U.S. Transistor Corp.**, Syosset, N.Y., for germanium PNP alloy junction transistors.

ARMY

$2,129,471—**Raytheon Co.**, Waltham, Mass., for replenishment repair parts for *Hawk* missile system.

$2,060,416—**Robert E. McKee General Contractor, Inc.**, and **Nordic Construction Ltd.**, Honolulu, for construction of dual *Nike-Hercules* battery.

$1,278,131—**Waldrip and Harvick Co.**, Long Beach, Calif., for a self-propelled seventeen-story service tower for servicing space missiles.

$1,352,900—**Price-McNemar Construction Co.**, Van Nuys, Calif., for construction of a single *Nike-Hercules* battery.

$1,143,500—**Sperry Utah Engineering Laboratory Div.**, for repair parts for the *Sergeant* missile.

$863,000—**Sperry Rand Corp.**, Salt Lake City, for repair parts for *Sergeant*. (Two contracts.)

$486,375—**Douglas Aircraft Co.**, Santa Monica, for launching area items.

$443,266—**Aerojet-General Corp.**, Azusa, for research and development.

$400,000—**Douglas Aircraft Co.**, Santa Monica, for *Nike-Hercules* launching area items.

$309,955—**Raber-Kief, Inc.**, Seattle, for *Nike-Hercules* guided missile field maintenance shop, Mt. Home AFB, Idaho.

$303,612—**California Institute of Technology**, for development of advanced *Juno II* clusters.

$228,667—**Western Electric Co.**, New York City, for *Nike* spare parts and components. (Four contracts.)

$224,864—**Emerson Electric Mfg.**, St. Louis, for components, repair parts and special tooling for *Little John* rocket.

$81,360—**Sperry Rand Corp.**, Utah, for *Sergeant* missile.

$41,275—**The Martin Co.**, Orlando., for furnishing technical advisory services for the *Lacrosse* system.

names in the news


BEGOVICH

Dr. Nicholas A. Begovich: Former director of engineering named assistant manager of Hughes Aircraft Co.'s Ground Systems Group and director of product line operations. Previous posts: Consultant to the Weapons Systems Evaluation Group of the Department of Defense, research engineer for the War Metallurgy Committee, and instructor in electrical engineering at California Institute of Technology.

Adm. Sherman E. Burroughs, Jr. (USN ret.): Named special assistant to the president at Librascope Division of General Precision, Inc. Was assistant to the president of the firm's parent company, General Precision Equipment Corp.

Dr. Albert C. Hall: Director of research and engineering for The Martin Co., named vice president-engineering with headquarters in Denver. Joined the firm in 1958 and has concentrated on the *Titan* program, of which he became engineering director in January, 1959.

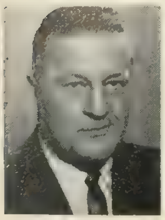
Joseph Hughes: Former Navy commander, joins the Electronic Systems Division of Dalmo Victor Co. as military advisor.

John F. Kramer: Transfers from Vickers, Inc. Electric Products Division's Cleveland office to the firm's Washington, D.C., office as district manager. **Thomas Orr** joins EPD to take over its Cleveland office.

James Marmor: Appointed contract coordinator of the Military Products De-

partment of The Garlock Packing Co. Was formerly with the Missiles and Space division at Lockheed, where he was technical coordinator for the *Polaris* program.

W. J. Wiley: Formerly manager of production programing and control, elected manager, missile manufacturing at Aerojet-General Corp.'s Downey plant. Previously held management positions with Consolidated Vultee, Ryan and Rheem Manufacturing Co.


WILEY

Sidney Wiesner: Former director of quality control for General Transistor Corp., joins Rheem Semiconductor Corp. as quality control manager.

Dr. Clark T. Randt: Former scientist for Space Medical Research, elected director of NASA's new Office of Life Sciences.

R. J. Miller: Formerly with Electronic Specialty Co., elected marketing manager of the Erie-Pacific Division of Erie Resistor Corp.

Bruno J. Pawlowski: Former chief engineer, appointed engineering marketing manager of The Gabriel Co.'s Electronics Division.

Warren E. Jackson: Joins Trans-Sonics, Inc., as a staff engineer. Was formerly chief engineer at Arthur C. Ruge Associates, Inc.

Earl H. Flath, Jr.: Joins Temco Aircraft Corp., Electronics Division as a senior scientist to plan developments in the fields of radiation, antennas and microwave systems.

S. K. Derderian: Appointed a member of the board of directors at Metal Hydrides Inc. Will continue to serve as vice president and general manager. Joined the firm in 1943 as an analytical chemist; appointed general manager in 1954 and elected vice president and general manager in 1955.


DERDERIAN

Dr. John V. Atanasoff: Elected vice president of Aerojet-General Corp., Atlantic Division. Was previously manager of the division.

Dr. Frank S. Stein: Former manager of Device Development at Westinghouse Electric Corp., Semiconductor Dept., joins General Instrument Corp. as manager of the Semiconductor Research and Development Dept. Under Dr. Stein will be **Dr. R. W. Hull,** as director of semiconductor research, and **Stanley Possok,** as chief of development.

L. J. (Jack) Findley: Appointed application engineer for the Aero Hydraulics Division of Vickers Inc. Was group engineer responsible for auxiliary power systems and flight test coordination at Douglas Aircraft Co. Major engineering assignments included analysis of the *Thor* missile ground support equipment.


FINDLEY

Howard J. Libby: Former Jacuzzi Brothers, Inc. controller, joins Epsco-West as assistant general manager.

John K. Hilliard: Named vice president and director, and **Dr. Walter T. Fiala,** chief physicist, of the newly formed Ling-Altec Research Division of Ling-Altec Electronics, Inc.

Dr. Arnold M. Small: Former manager of the reliability and quality assurance laboratory, appointed manager of the product effectiveness laboratory of Hughes Aircraft Co., Ground Systems Group. Prior to joining the firm in September, 1959, was engineering staff specialist at Convair; head of the human factors division of the San Diego Naval Electronics Laboratory, and head of the psychological acoustics section of the University of California.

Jesse Stitzer: Named engineering manager at Sorensen & Co., a subsidiary of Raytheon Co. Formerly manager of High Voltage Systems Laboratory.

Donald R. Seals: Former chief chemist for Climax Molybdenum Corp., elected research chemist for the Frank R. Cook Co., a subsidiary of Telecomputing Corp.

A reorganization of the Research subdivision of Rocketdyne, division of North American Aviation, Inc., has brought about the following changes:

Dr. Jack Silverman, promoted to chief in charge of chemistry; **Dr. L. C. Struckenbruck,** chief of solid propulsion; **Dr. R. S. Levine,** chief of the physical processes section; **S. P. Greenfield,** chief of liquid propulsion section; **J. E. Witherspoon,** head of physics and mathematics group; **Dr. R. B. Lawhead,** process dynamics; **Dr. K. H. Mueller,** experimental chemistry; **G. S. Gill** and **J. V. Hobbs,** group scientists for liquid engine applications and research instrumentation; **Charles Bernstein,** propellants and polymers; **R. D. Sheeline,** solid propellant applications, and **C. H. Martinez,** special projects.

reviews

TELEMETERING SYSTEMS, Perry A. Borden and W. J. Mayo-Wells. Reinhold Publishing Co., New York. 349 pp. $8.50.

This badly needed basic text is the first authoritative work in this field in several years.

Written by two men who have been intimately connected with telemetry since its early days, the book covers all aspects of both industrial and military systems. It includes the latest developments and contains existing authoritative standards.

It is written without resort to complicated mathematics and can be easily understood by anyone with an interest in the field. The stated objective of the book is to provide a working knowledge of the principles and practices of present-day telemetering and its use in a wide range of applications. It describes the wide range of telemetering systems, their history, uses, limitations, basic components and subsystems.

HOW TO USE METERS, Second Edition. John F. Rider and Sol D. Prensky. John F. Rider Publisher, Inc., New York 11, N.Y. 216 pp. $3.50.

This book satisfies the practical interest of those concerned with measuring devices, their basic principles and application. The most advanced developments—transistorized voltmeters, digital displays, refined laboratory instruments which provide greatly increased sensitivities, indication features in meters providing long-arc (250°) meter scales—are brought to the reader.

Details are given on construction, operation, and application of all types of electrical meters used for making different kinds of measurements in electronic and electrical equipment, and industrial applications.

In the new chapters on specialized measurements and advanced meter features, attention is given to the important extension of measurement capability.

RADIATION COUNTERS AND DETECTORS, C. C. H. Washtell. Philosophical Library Inc. New York 16, N.Y. 115 pp. $7.50.

The book was written to provide a simple introduction to radioactive detectors and measurement techniques for the reader with a general scientific background whose work involves making radioactive measurements.

Material includes the atomic structure, radiation detectors, Geiger-Muller tubes, other types of detectors based on ion collection and methods of detection not based on ion collection.

THE AERODYNAMICS OF POWERED FLIGHT, Robert L. Carroll. John Wiley & Sons, Inc., New York. 273 pp. $8.50.

This book is intended to be an introduction to the aerodynamics of powered flight. The simplicity of presentation makes the book useful as an instrument of self-study for professional personnel working in the field.

Since the rocket as a system affords the greatest simplicity of analysis, the concept of lift has been based on the analysis of rocket thrust.

The presentation throughout is thoroughly modern, and many of the topics covered are ones which older books either neglect or treat inadequately.

MOON BASE, TECHNICAL AND PSYCHOLOGICAL ASPECTS, T. C. Helvey. John F. Rider Publisher, Inc., New York. 80 pp. $1.95.

Main problem areas in the construction of a moon base are explored from a simple, but technical, viewpoint. In selection of a crew for this base, the author proposed a team made up of two men and a woman.

The author also explores the design of a moon-base prototype and discusses the technical description of some of the features of a prototype and the psychological analysis of the smallest operational

RESEARCH HIGHLIGHTS OF THE NATIONAL BUREAU OF STANDARDS, Annual Report 1959. Order National Bureau of Standards Miscellaneous Publication 229, from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. 169 pp. $.55.

This illustrated report brings together the most important developments in the research program of the Bureau during 1959. It describes a wide range of scientific studies, laboratory experiments, and instrumentation developments.

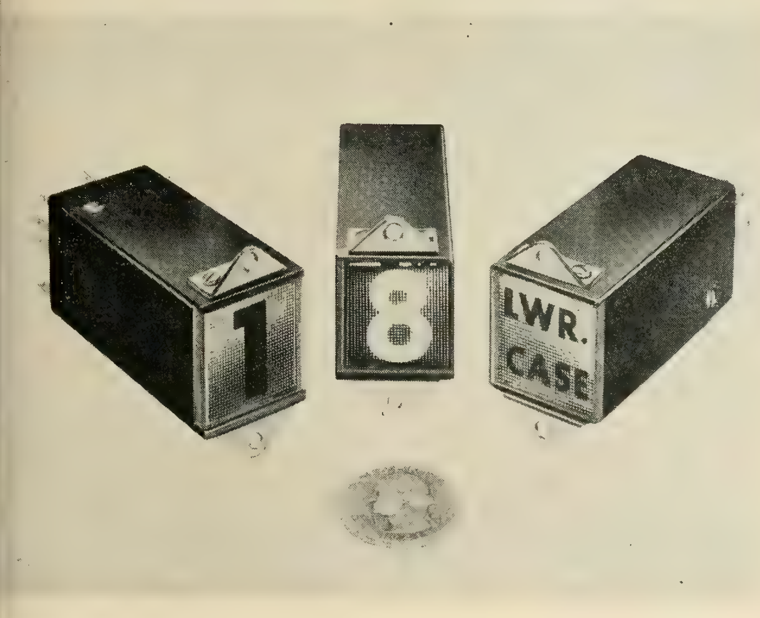
Much of the material is concerned with the new technology of the Space Age. Progress is reported in extending the calibration range of optical pyrometers from 2400° to 3800°C, development of a high-current arc as a source of controlled temperatures, and design of a special type of high-temperature resistance thermometer for interpolating between fixed points on the International Temperature Scale.

There are reports on special efforts to improve the high temperatures. Some of these studies deal with solid-state reactions in high-temperature alloys, refractory coatings for aircraft and missiles, and new cements for high-temperature strain gages.

Radio research includes ionospheric soundings, development of a communications system which reflects messages off meteor trails, refraction of radio waves in the earth's atmosphere, and many other topics.

The report also summarizes the Bureau's Calibration, Testing and Standard Samples, programs, publications program, and cooperative research with industry. A brief summary of some of the programs planned for this year is included.

products and processes



Tiny Digital Display Developed

A miniature incandescent digital readout which displays the digits zero through nine on a common 1" x 1" area is now available from the Burroughs Corporation, Electronic Tube Division, Plainfield, New Jersey. The unit (Type LD-11) presents high density white-on-black (or black-on-white) numerals instantaneously with the lighting of each bulb. Special units which can display as many as ten complete messages in the same 1" square viewing area are also available.

The LD-11 utilizes an adaptation of Burroughs' lenticular optic technique which eliminates the need for projection lenses. The result is a display which is free from the common defects of incandescent displays; i.e., non-uniformity due to lens distortion and partial illumination caused by filament sublimation and sagging. Other outstanding advantages are its modular construction designed for direct panel mounting and its small over-all size (1" x 1" x 3") which reduces the behind panel space requirements.

The unit is offered with long life bulbs designed for operation from 2½, 6, 12 or 28 volt systems. The display is easily read from a wide angle of view and complements the existing line of Burroughs display devices; LD-22 and LD-35 Multi-Message Displays (16 or 20 messages on 2½" x 2½" or 3" x 5" viewing screens) and Ultra Long Life NIXIE Indicator Tubes.

The LD-11, utilizing a 2½ volt bulb, is priced at $24.00, in quantities up to 99. This miniature readout is immediately available from stock.

Circle No. 225 on Subscriber Service Card.

Wire Soldering Dispenser

Kormat, a new wire soldering dispenser developed by PFI Products, is a safe, cost-reducing wire solder dispenser tool offering broad application flexibility to the point of solder.

The unit's push button feeder adjusts the right amount of solder for each and every application—not too much or too little—the ideal solution to wire.

A selection of attachments including straight or curved probes in several lengths for hard-to-get-at areas, and a 20 ft. roll of 60/40 rosin core solder of .050" diameter wire are available. Flip action reloads wire solder in seconds.

Circle No. 226 on Subscriber Service Card.

Portable X-ray Unit

The Norelco PG 300, a new portable industrial X-ray unit that provides high penetrating power and excellent radiographic definition, is available from Philips Electronic Instruments.

Completely self-contained, the new unit is shockproofed, rayproofed and weatherproofed for outdoor operation.

Safety Devices effectively prevent overload on the tube. Tubehead weighs only 231 lbs. and therefore may be hoisted to remote areas for radiography of more than 3 inches of steel.

Emergent beam angle is 40 degrees and focal spot size is 2.3 mm. X-ray voltage is continuously adjustable under load in a stepless range from 65 to 300 kv. Load rating is 5 ma (milliamperes) up to 260 kv and 4 ma from 260 to 300 kv. Duty cycle is 100% continuous with water cooling—intermittent with air.

Oil insulated, with inherent filtration equivalent to 4 mm of aluminum, the PG 300 tube head has a diameter of 9⅜ in. and is 47⅝ in. long, including handles. Control cabinet measures 19 in. by 12⅝ in. by 11¼ in. and weighs 77 lbs.

Power requirement for the PG 300 is 220 volts, 50/60 cycles, 9 amperes. An automatic reset timer is included with the control unit.

Circle No. 227 on Subscriber Service Card.

Missile Valved Couplings

Development of a "15 Series" quick connect-quick disconnect valved coupling, designed primarily for military and missile applications, has been announced by SnapTite, Inc.

The new series is a self-sealing coupling designed for "no-spill" service in accordance with military specifications for use in airborne and ground hydraulic systems.

Variations have been designed to meet special coupling situations, such as remote handling of liquefied gases. The couplings are available in ¼ to 1¼ in. sizes. The new "15 Series" couplings also may be used with fuels and other fluids with working pressure up to 3000 psi, and temperatures up to 400°F in the ¼ in. size.

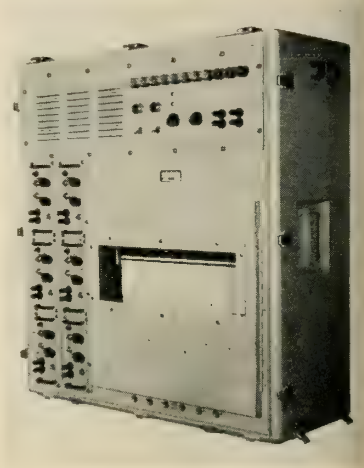
Circle No. 228 on Subscriber Service Card.

Six Channel Recorder

A six channel, AC-DC recorder has been developed. High stability and virtual drift free operation are obtained by positioning the recording stylii by means of servomechanisms instead of the conventional galvanometers. The stylii are thermal writing and product rectilinear traces.

Initial application of the instrument is for recording error signals from fire control computers used with shipboard guided missile systems.

In addition to recording signals with a bandwidth of from 0 to 30 cps, each channel is capable of accepting modulated signals on both 60 cps and 400 cps carriers and provides a phase sensitive recording with no additional equipment required. The type of signal to be recorded is selected by a front panel control on each amplifier. Maximum sensitivity of each channel is approximately 2.5 millowatts per millimeter of stylus deflection. Minimum



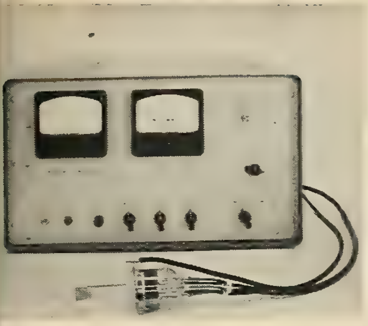
sensitivity permits recording signals of up to 300 volts peak to peak.

Each recording channel is 5 centimeters wide. The zero position of the recording stylii may be placed anywhere within the channel by means of a front panel zero offset control. Two event marking channels are also provided in addition to the six recording channels. The recorder may be mounted in either a vertical or horizontal table top position.

Circle No. 229 on Subscriber Service Card.

Vacuum Gauge Control

An ionization gauge control that overcomes the zero drift tendencies inherent in ultra-high vacuum models and that meets both the emission and out-gassing requirements of any Bayard-Alpert type ionization gauge, in-



cluding the Nottingham Gauge has recently been developed by NRC Equipment Corp.

The new control, designed to measure from 10^{-3} to 10^{-10} mm Hg by direct methods, and from 10^{-10} to 10^{-12} mm Hg by indirect methods, will indicate pressures down to the limit of detectability of the gauge tube within ±5% of full scale. Pressures of these magnitudes are of prime interest to engineers and scientists engaged in research and production of subminiature electronic elements, in space simulation, in thermo-nuclear apparatus, and in general process and materials studies relating to solid state physics.

High stability, convenient operation, and the ability to outgas and read any of the ultra-high vacuum ionization gauges are the outstanding characteristics of the new control.

Most gauge controls must be zero set after relatively short periods of operation or shutdown. With the Model 751 control, zero drift is less than 1% of full scale in 24 hours. A typical production control, after 24 hours of operation, displayed no discernible drift over the next 72 hours. The same control, turned on after a 24-hour shutdown, required no zero adjustment. This stability is achieved with a specially designed electrometer circuit. The output is linear from 0 to better than 20 volts, and line voltage variations from 105 to 125 volts will not affect the reading.

Circle No. 230 on Subscriber Service Card.

Oscilloscope Camera

A versatile, simplified oscilloscope recording camera is introduced by Beattie-Coleman. Known as the "Minute Man Oscillotron," it features a Polaroid Land back providing either 60 second prints or transparencies. Attaches to any 5" Oscilloscope. Swings out, lifts off for easy accessibility. Light and compact, it is a precision instrument built for continuous duty. Wollensak 75 mm f/2.8, f/1.9 standard or f/1.9 flat-field lenses are interchangeable.

Of modular design, it can instantly

be converted to record a wide range of object-to-image ratios, and can be removed from oscilloscope for other instrumentation photography.

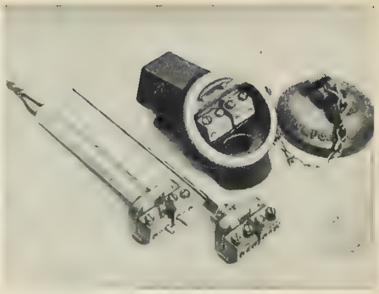
Easily attached accessories include: Binocular viewing hood; adapter to record up to 10 traces on a single frame; 35mm pulse camera; 35mm continuous motion magazine; data chamber with watch, platen and counter; data card to record in frame; external focusing control; electric shutter actuator.

Circle No. 231 on Subscriber Service Card.

Heavy Duty Thermocouple

The E. C. Smith Mfg. Co., Inc., has announced a new, small-size industrial thermocouple connection-head which is rugged, weather-proof, and is designed for high-ambient temperature and corrosive-atmosphere applications. Called Mini-Head, it is the first to use an all-stainless-steel chain and non-removable screws. The screw cover absolutely cannot be dropped or mislaid.

Made of semi-steel, the new connection-head contains a high-temperature refractory terminal block which will fit B&S No. 7 gage or smaller T/C wires, and B&S No. 12 or smaller extension wires. A special heat-and moisture-resistant gasket is retained in



the cover to assure a tight seal.

The Mini-Head accommodates both conventional thermocouple wire-elements and the new metal-sheathed thermocouples featured in Smith's Cerami-Kouple line. Special adapters hold four sizes of metal-sheathed thermocouples: 1/16", 1/8", 3/16" and 1/4". A red silicone paint protects the connection head.

Circle No. 232 on Subscriber Service Card.

Pressure Sensitive Adhesive

A new pressure sensitive adhesive that is particularly suited for general purpose applications, including the bonding of fabric, paper, wood, plastic, glass, metals and many other materials, has been announced by Schwartz Chemical Co., Inc.

The adhesive is supplied with heavy syrup viscosity for fast drying application with brush, roller or Doctor Knife. It remains soft and can be used within a few minutes or covered with release paper for deferred use. One gallon will prepare approximately 200 square feet.

Circle No. 233 on Subscriber Service Card.

New Literature

REMOTE CONTROL. A 12-page color catalog on mechanical remote control systems for the missile industry is available from Teleflex Inc. Typical control systems described are: gate valve operation; umbilical cord disconnect; main fuel control; and nozzle feedback. Engineering information is listed tabularly, including cable sizes, minimum bend radii, weights, maximum operating loads, materials, temperature ranges, and physical dimensions.

Circle No. 200 on Subscriber Service Card.

FASTENERS. A 24-page illustrated catalog describing the complete line of Huck fasteners is now available from Huck Manufacturing Company. It includes discussion of a broad variety of tension and featherweight Huckbolt fasteners, self-broaching Huckbolt fasteners, self-sizing Huckbolt fasteners, pull-thru blind rivets, friction-lock self-plugging blind rivets and lock-spindle self-plugging blind rivets. Driving cycles, strength data, typical applications, grip ranges, significant dimensional data, hole size recommendations and installation notes are included for each fastener in the Huck product line.

Circle No. 201 on Subscriber Service Card.

HAND TORCHES. Air Reduction Sales Company has issued a newly-revised 36-page catalog on its line of gas welding and cutting hand torches, outfits, tips and accessories. The company's complete group of equipment is covered in detail with general descriptions, features, specifications and photographs given for each product. Also included are specification charts on Airco welding and cutting tips listing all pertinent information that a user might need to make the proper selection for both general purpose and special gas welding and cutting.

Circle No. 202 on Subscriber Service Card.

ELECTRICAL PRODUCTS. Two new catalogs have just been issued by Buchanan Electrical Products Corporation. Both cover Buchanan sectional and one-piece terminal blocks, solderless connectors for wire splicing and terminating, squeeze-type connectors for non-metallic sheathed cable, insulated conduit bushings and knock-out plugs.

Manufacturing and Production Catalog No. 76 is especially prepared for design engineering, production and purchasing personnel. It features complete technical data, detailed engineering specifications and drawings on Buchanan sectional pressure-blocks. Contracting and Maintenance Catalog No. 35 is especially prepared for electrical contractors and plant maintenance departments. It features Buchanan pressure-connectors for wire splicing and terminating.

Circle No. 203 on Subscriber Service Card.

INDUCTION HEATING. A folder on induction heating equipment for automated metal heating has been published by Robotron Corp., Detroit, manufacturers of industrial electronic controls. It explains company technical services available to the customer—problem analysis, research, design engineering and manufacture of tailor-made end product—with illustrations of facilities and equipment to do the job.

Circle No. 204 on Subscriber Service Card.

ELECTRON TUBES. Latest trends in the design and manufacture of electron tubes for entertainment, industrial and military applications are discussed in a new booklet published by Sylvania Electric Products Inc.

Circle No. 205 on Subscriber Service Card.

—when and where—

MARCH

Electronics Industries Association, Defense Planning Seminar, Statler Hilton Hotel, Washington, D.C., March 15.

Institute of Radio Electronics, 1960 International Convention, Waldorf-Astoria and New York Coliseum, New York City, March 21-24.

American Rocket Society, Ground Support Equipment Conference, Statler-Hilton Hotel, Detroit, March 23-25.

Symposium on Optical Spectrometric Measurement of High Temperatures, sponsored by University of Chicago's Applied Science Laboratories, Jarrell-Ash Co., National Science Foundation, University of Chicago, March 23-25.

22nd Annual American Power Conference, sponsored by Illinois Institute of Technology, American Society of Mechanical Engineers and others, Sherman Hotel, Chicago, March 29-31.

APRIL

University of Connecticut, Sixth Annual Advanced Statistical Quality Control Institute, Storrs, April 3-15.

Solar Energy Symposium, American Society of Mechanical Engineers, and Mechanical Engineering Dept., University of Florida, Gainesville, April 4-5.

Advertiser's Index

'Freedom of Space?' Who Says So?

Congress is considering certain changes in the National Aeronautics and Space Act of 1958. They are largely administrative.

They do not alter the fact that nothing important will be done in space, no important program started, no important goal set unless the President, whoever he is or may be, personally orders it.

They do not alter the basic fault of the law—the fact that it attempts to define the roles of NASA and the Department of Defense in space by *program* rather than by mission. It is probably the only important similar legislation on the U.S. statute books so written.

The President and the Administration, who in effect dictated the Space Act, have repeatedly held that the military has no mission in space.

This is like saying the military has no mission on the sea, on the ground or in the air.

The military has a mission in space simply because space is there.

This mission no more quarrels with the role of NASA than the mission of the Navy quarrels with that of the President Line or the mission of the Air Force quarrels with that of TWA.

The mission of the military does guarantee the right of merchant ships and commercial airliners to operate free of predacity and tribute. Its mission anent NASA or any other American enterprises in space should be equally recognized and established.

In other words, as NASA is given the mission of exploring space for peaceful purposes, the military should be given the mission of guaranteeing that NASA (the U.S.) is duly protected at all times in carrying out its task.

Then the military could work out its program based on such a mission and budget for it—in the same way it now plans and budgets in other areas its job of protecting this country against potential enemies.

After defining NASA's role in peaceful exploration of space for scientific purposes, the National Space Act amendment dealing with the military role backs into the problem thusly:

"Sec. 309. (a) Nothing in this Act shall preclude the Department of Defense from undertaking such activities involving the utilization of space as may be necessary for the defense of the United States, including the development of weapon systems utilizing space vehicles and the conduct of supporting research connected therewith."

And then yanks the rug out with:

"(b) In order to accomplish the most efficient utilization of resources, responsibility for the development of each new launch vehicle, whether intended for use by the Administration (NASA) or the Department of Defense or both, shall be assigned by the President to either NASA or the Department of Defense."

We submit that as the military has the mission of otherwise defending the United States, it equally should have the job of defending our right to travel in and to explore space; it should have the mission of guarding against enemies who may try to deny us such exploration or try to use space as a battleground against us.

The National Space Act should say to the military "This is your mission. Coordinate with NASA. Submit a program to Congress and the people that looks ahead ten or even twenty years—a program which accomplishes your mission to the best of your ability."

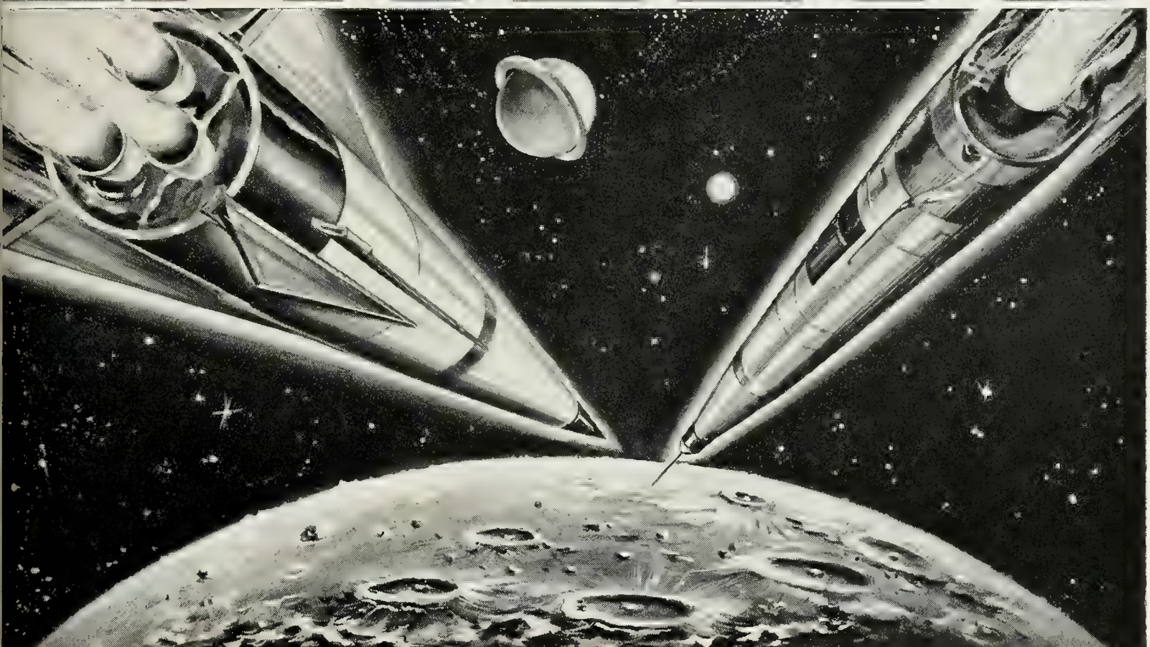
The National Space Act has a well-meant, even noble preamble. It reads:

"The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind."

When—when in this world has it ever been possible to maintain a peace without maintaining the means to defend it fiercely?

Clarke Newlon

EXCELCO



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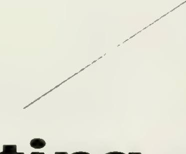
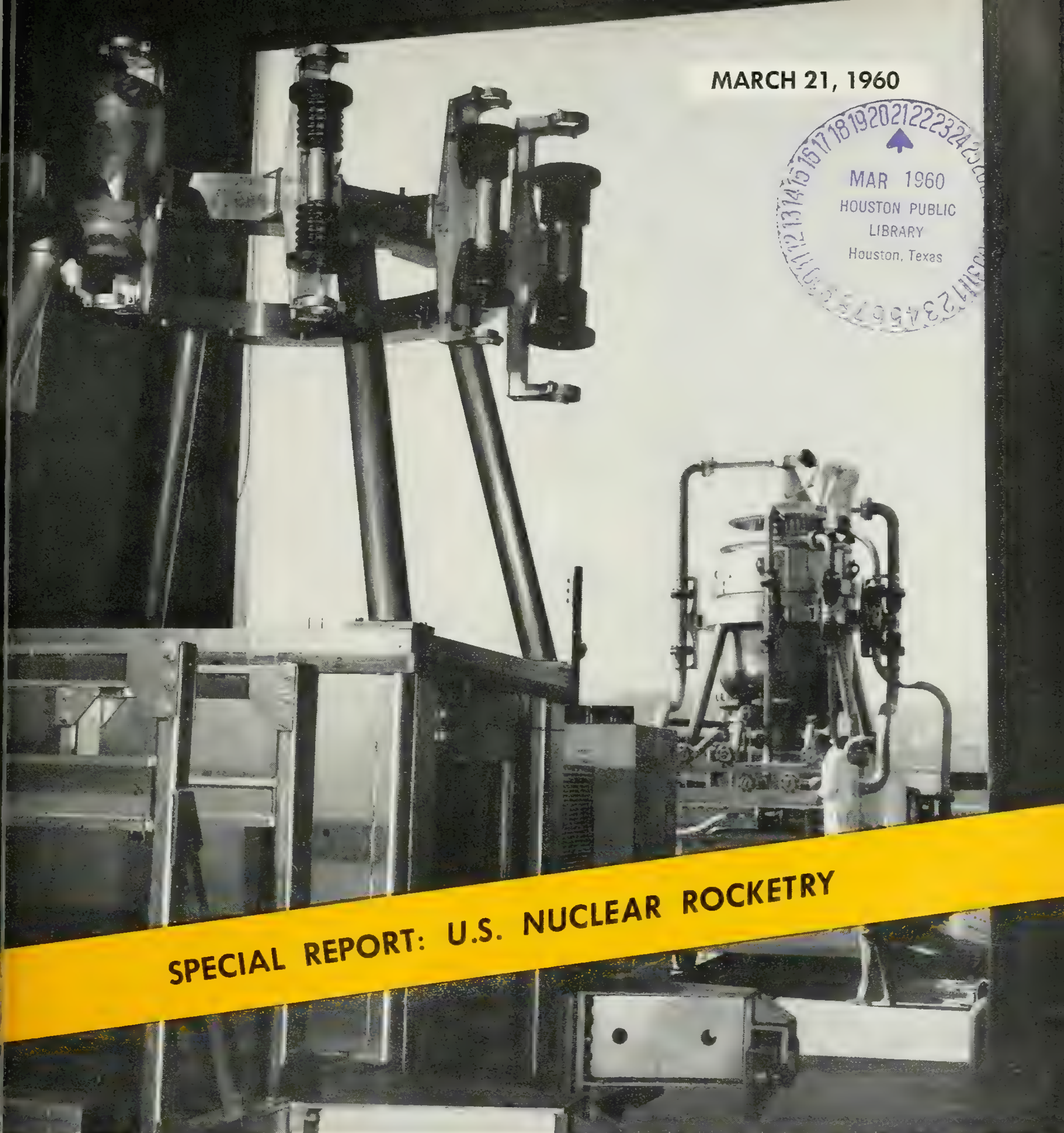


MARCH 21, 1960



SPECIAL REPORT: U.S. NUCLEAR ROCKETRY

missiles and rockets

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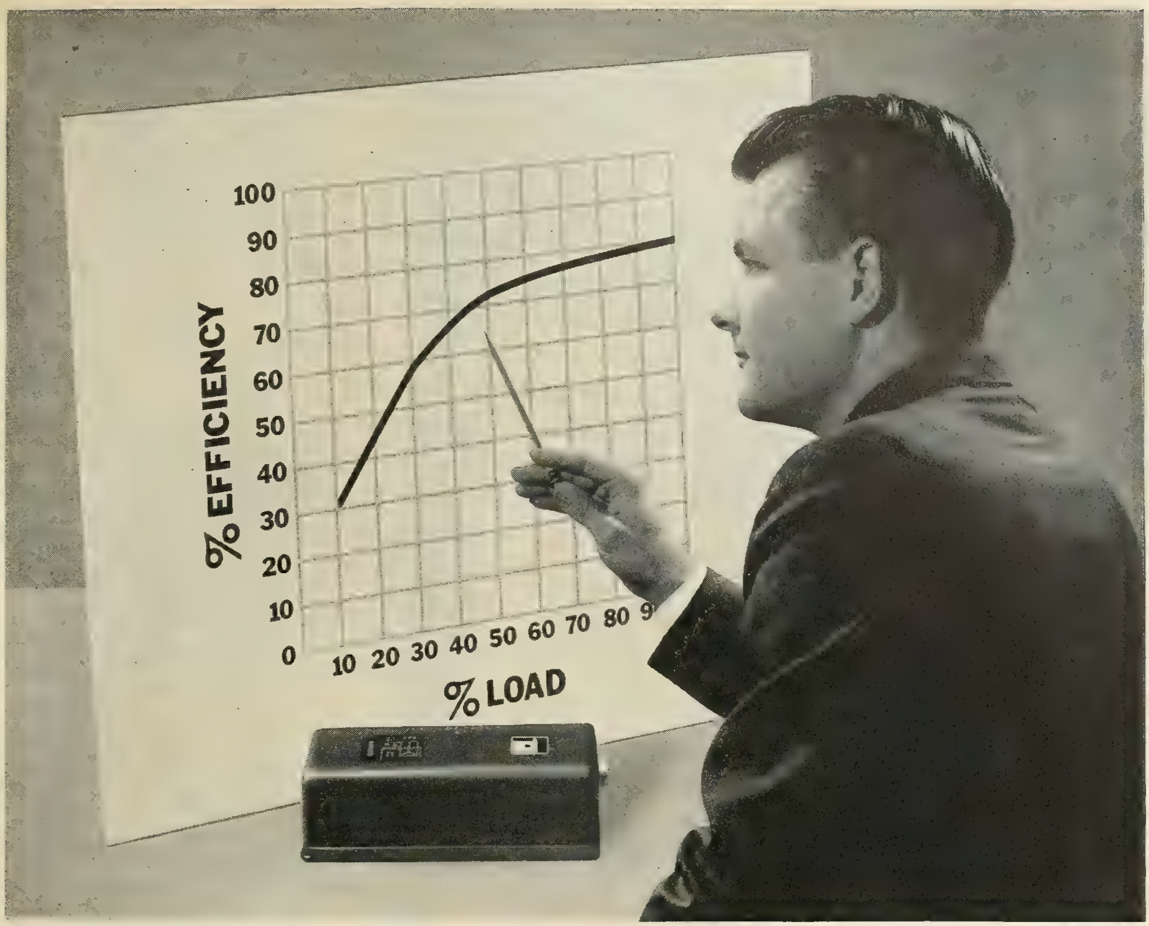

Over 70% efficiency at only half load with the Kinetics Static Inverter

Close frequency control and accurate phase displacement is obtained with crystal-controlled digital countdown circuitry.

The nearest approach yet to a flat efficiency curve for a static inverter is achieved by a new Kinetics design. Even at a fraction of full load, good efficiency is obtained. The Kinetics unit is ideal for aircraft and missile applications in the range from 15 VA to 15 KVA per phase.

There are no moving parts, no vacuum tubes and no transistors in high current circuits in the Kinetics inverter. The design features rugged silicon semi-conductor elements that are able to carry heavy current without failure. A common complaint about transistorized inverters is that they must incorporate cutoff devices in order to protect extremely sensitive power circuits from short circuits or high voltage transients. The silicon diodes will carry extremely heavy overloads, including shorts, for several seconds. This is usually long enough to trip the circuit breaker in the circuit carrying the short.

The Kinetics design offers low-loss regulation and the output is very nearly a perfect sine wave. A high degree of reliability is achieved by the use of extremely rugged components and the lack of complex circuitry. The Kinetics inverter is relatively unaffected by severe environmental conditions. Write or phone for more information. Kinetics Corporation, Dept. K-19, 410 South Cedros Avenue, Solana Beach, Calif. SKyline 5-1181.

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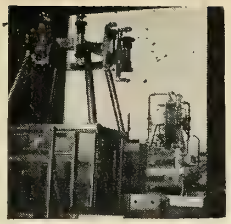
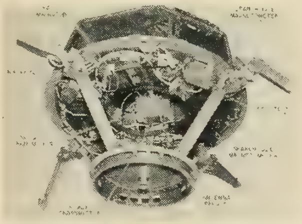


COVER: Crew works on mock-up of *Kiwi-A*, the nation's first nuclear rocket engine, at the Atomic Energy Commission's Nevada Test Site. A report on the status of this vital program starts on p. 18.



PAYLOAD of *Pioneer V*, mankind's first significant planetoid. The 94.8-lb. system has transmission more powerful than that of any previous space vehicle. A story on the historic launching begins on p. 12.

REPUBLIC scientist studies vegetables growing in low-pressure "lunar greenhouse" designed to show how astronauts might grow food. For a report on how Republic is expanding R&D to meet Space Age, turn to p. 14.

STEEL casting is poured in seven seconds at American Brake Shoe Co., where a process developed for power shovel fabrication has resulted in castings with 280,000 psi tensile strength. See p. 36.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

31,200 copies this issue

MARCH 21 HEADLINES

PROPULSION ENGINEERING

ASTRIONICS

GROUND SUPPORT EQUIPMENT

ADVANCED MATERIALS

PRODUCTS AND PROCESSES

THE MISSILE WEEK
U.S. Reg. Pdg.

DEPARTMENTS

KEARFOTT developed and now produces the $\boxed{\text{Bomarc-B}}$ all-attitude mid-course guidance system.

***Engineers:** Kearfott offers challenging opportunities in advanced component and system development.*

KEARFOTT DIVISION

GENERAL PRECISION INC.

LITTLE FALLS, NEW JERSEY

Other Divisions of General Precision Inc.—GPL—Librascope—Link

Circle No. 4 on Subscriber Service card.

the missile week

Washington Countdown

IN THE PENTAGON

Air Force space shots . . .

scheduled within the near future:

. . . The first launching of an R&D *Samos* reconnaissance satellite.

. . . The second launching of an R&D *Midas* early warning satellite.

• • •

Tactical antimissile missiles . . .

are a growing Army requirement. The need is for a missile capable of downing Russian versions of U.S. *Sergeants, Honest Johns* and *Pershings.*

• • •

Installation of *Asroc* . . .

antisubmarine missiles aboard surface ships is expected to cost more than $1 million for each system. The Minneapolis-Honeywell missile is expected to be operational next January.

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First undersea launching . . .

of a live *Polaris* is now scheduled for March 25 from an underwater launching pad off San Clemente Island. The Lockheed missile will have a cut grain, reducing its flight to only a short distance.

• • •

Soviet IR spies . . .

are reported to be keeping watch on British *Thor* bases. The Reds are understood to be using infrared cameras aboard high-altitude reconnaissance aircraft.

ON CAPITOL HILL

Part payment . . .

for proposed congressional increases in spending for *Atlases* and *Polarises* may come from the hide of the *Bomarc* program. House Defense Appropriations Subcommittee members are honing their knives.

• • •

The big question . . .

is whether Congress can bring enough political pressure on the Administration to spend extra dollars for more strategic missile power. Present indications are the Administration will spend some of the extra money but not all.

AT NASA

The return of *Vega* . . .

to the active list of NASA programs is understood to be a strong possibility. General Electric completed about a dozen of the 35,000-pound-thrust X-405 H upper-stage engines for the *Vega* program before NASA axed it. Now NASA may try to get back some of its money by using them.

• • •

Old and battered things . . .

sometimes are best. *Pioneer V*'s payload, which had been picking up rust and dust at Cape Canaveral for months, had to be given last minute first aid. The *Able* upper stage used in the successful launching was the one damaged by faulty crane handling and removed from an ill-fated *Atlas-Able* vehicle last November.

• • •

Opening day . . .

for the new Goddard Space Flight Center is scheduled for next August. All of the center's three buildings will be completed and occupied by November. The NASA budget allows for a 786-man staff.

INTERNATIONAL

Swedish space exploration . . .

will move forward on two fronts:

. . . The launching of sounding research rockets purchased either in the United States or Japan.

. . . Development of Swedish research rockets by Svenska Aeroplan Aktiebolaget for later space exploration.

• • •

More missile ships . . .

will join the navies of five European nations. Britain, France, Russia, Italy and Sweden have announced plans to begin construction of missile ships or conversion of older ships for missiles this year.

• • •

Purchase of *Skylarks* . . .

is reported under consideration in the United States. The British solid-propelled research rocket has a thrust of more than 11,000 pounds. The Royal British Aircraft Establishment manufactures it.

VICKERS ECM COOLING SYSTEM *plus*

3M's FC-75 dissipates 47 kw input in 74 lb package

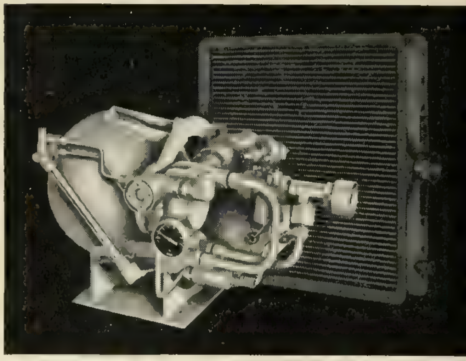
Vickers' 38 years of specializing in handling of fluids has been directed to "application-tailored" airborne cooling systems . . . reliable systems that are light weight and feature a broad range of flow and pressure characteristics.

This typical Vickers system circulates Minnesota Mining and Manufacturing Co.'s heat dissipating dielectric coolant, FC-75, through Sperry's advanced design electronic countermeasures system.

Heart of the Vickers cooling system is a single-stage, centrifugal pump that generates relatively low pressure and moves fluids at high flow rates. Because it is inherently simple in design, the Vickers pump offers high reliability and simplifies maintenance. Bearing design permits operation with fluids having low viscosities, in this instance FC-75, a fluordinated hydrocarbon.

Included in this package are safety interlocking devices for the protection of the pumping unit and ECM system. Maximum operating efficiency is assured even under unusually severe operating requirements. Such assurance stems from Vickers proven skills developed by long experience in designing and building components and systems for handling all types of fluid.

Write for Bulletin A-5244 for more details.



PUMPING UNIT AND CORE. Large airborne cooling system developed by Vickers' Aero Hydraulic Products division makes efficient use of 3M's FC-75 dielectric coolant to dissipate heat from electronic countermeasures equipment. Output pressure is required to be approximately 100 psi with fluid flow rates as high as 52 gpm. Operating range is from —65°F to 210°F. Pumping unit weighs 54 lb. dry and the heat exchanger core only an additional 20 lb. Shown below is part of the extensive testing program conducted by Vickers to prove out the new design. It included extremes of heat and cold as well as vibration, shock, attitude and other physical tests.

8485

AERO HYDRAULICS DIVISION
VICKERS INCORPORATED
DETROIT 32, MICHIGAN

division of
SPERRY RAND CORPORATION

the
missile
week

Industry Countdown

MANUFACTURING

In the wind . . .

a procedural change in the way the Air Force tackles the development of new weapon systems. Starting late this year, ARDC will establish "Technical Forecasts" for industry, replacing the present Technical Program Planning Document and Applied Research Planning Document Release programs. The new "forecasts" will contain a summation of research to be done in a particular technical area, programed by years—enabling industry to plan far into the future to meet Air Force requirements.

• • •

ARDC's new approach . . .

will be built around a three-step planning philosophy—basic weapon system studies, analysis of the systems under a Technological Force Structure Plan, and a Planning Objective Structure. Planning Objectives will have two dates; one for when applied research required by a new weapon is expected to be complete, and the second for when the weapon is expected to enter the operational inventory.

• • •

Out-of-pocket outlay . . .

of $28 million for new research facilities caused United Aircraft's 1959 earnings to drop sharply. Earnings were $28.6 million on sales of $1 billion, compared to 1958 profits of $42 million on sales of $1.2 billion. The company, now moving into the solid rocket field, hopes to recoup in 1960.

• • •

New entries in missile . . .

electronics field are Sunbeam Corp. and General Mills. Sunbeam is buying John Oster Mfg. Co. of Milwaukee for $13 million and General Mills is acquiring the Daven Co., Livingston, N.J., electronic component supplier.

PROPULSION

Failure in a generator valve . . .

in the second stage caused the unsuccessful flight of a *Titan C-1* fired March 7. During the second-stage engine start sequence, the valve failed to open and start sequence terminated. Flight continued along trajectory established by first stage.

Three industry groups . . .

want the AEC to allow industry to convert and fabricate the uranium fuel elements for the Project *Rover* nuclear rocket. The Manufacturing Chemists Association, National Association of Manufacturers, and Chamber of Commerce are urging Congress to look into government competition with industry in the atomic field. AEC says the uranium is drawn from stocks maintained for nuclear warheads.

ASTRIONICS

Gyro drift rate . . .

for Air Force ICBM's, now set at a maximum of 0.0001%, is creating a fantastic accuracy requirement for the manufacturers of miniature precision ball bearings. Only six bearings are used in an inertial system, but manufacturers find they must produce more than 500 to get a half-dozen that are acceptable.

• • •

Guidance packages . . .

could be produced in about three months, except for the bearing problem. They have a five-month lead time.

• • •

Big counter-countermeasures . . .

push has been started by the Navy to protect the *Terrier, Tartar* and *Talos* missiles from jamming. A new study has revealed that "one or more portions" of these missile systems can be jammed by likely enemy countermeasures.

WE HEAR THAT

Rumors in Paris . . .

have Bell Aircraft negotiating with Nord for the U.S. license to make the *CT 41* Mach 2 target missile . . . The U.S. Army expects to be using upwards of 75,000 electronic emitters during the 1960's in field commands . . . Avien Inc. is making a double acquisition—Colvin Laboratories and Pressure Elements Inc., both located in East Orange, N.J. . . . The G. H. Leland Inc. has been pushing its solenoids and line of switch gear for missiles for years under the trade name "Ledex." As of April 1, the company has decided to drop its present name and take Ledex Inc. as a new title . . . Even big companies find the old saw "if at first you don't succeed, try, etc." pays off. A disclosure by RCA's Dr. N. I. Korman: RCA made more than 50 presentations to the Air Force before it was awarded the BMEWS prime contract.

Liquid Hyperjet Passes Tests

Marquardt's combined rocket and ramjet engine with boron fuels proposed for advanced Bomarc, has other uses

by William J. Coughlin

LOS ANGELES—A liquid-fueled hyperjet engine under development for the Air Force by Marquardt Corp. has been flight-tested successfully at Edwards Air Force Base, MISSILES AND ROCKETS has learned. The test vehicle was a modified Lockheed *X-7*.

The hyperjet is a combined rocket and ramjet engine which has been proposed for an advanced version of the Boeing's surface-to-air *Bomarc*. It also has application in the air-to-surface, target drone and space fields.

Flight test at Edwards has proved out efficiency of the engine for speeds of Mach 4-8.

Boron fuels have been employed to power the hyperjet, which is designed to combine the optimum performance of a rocket engine with the optimum performance of a ramjet in a single, integrated engine system.

Most of the test work has been on a small scale, although some large-scale testing has been carried out at Edwards. The test program has been short and relatively inexpensive, it was learned, but the performance demonstrated is said to have been attractive.

• **I_{sp} doubled**—Marquardt says the hyperjet "delivers twice the average specific impulse of today's best rockets, permitting heavier payloads at minimum cost."

The company would not comment further on the engine or on the test program.

Work on the engine began under an Air Force contract because of its possible application to an advanced *Bomarc*. Its use would enable a surface-to-air missile to take off on rocket power at early warning of an enemy bomber or ballistic missile launch, cruise on ramjet power in the area where penetration was expected, and then revert to rocket power for the final attack.

Such an engine also could have an application in Project *CLAM* (chemical low altitude missile). Most promising field for the range-limited chemical hyperjet would be in an air-to-surface low-altitude missile. Its potential as a target drone is obvious.

Marquardt also is working with Grand Central Rocket Co. on a hybrid engine which employs a solid propellant in its rocket-ramjet combination and could be used in the above ways.

Most attractive space application of the hyperjet engine appears to lie in its use as a powerplant for a "space truck" which would carry material to an orbiting space station. This ability to make use of the earth's atmosphere would reduce costs well below those of conventional rockets.

• **Boron revival**—One of the most interesting aspects of the development of the Marquardt hyperjet has been its use of boron fuels similar to those scheduled for the chemically-powered version of the North American Aviation B-70 supersonic bomber.

(Plans for two large boron fuel plants were cancelled when the B-70 program was dropped. These were the Olin-Mathieson plant at Niagara Falls, N.Y., and the Callery Chemical plant at Muskogee, Okla.)

Virtues of boron hydrides as a fuel in the hyperjet engine include their high heat of combustion and relatively low-molecular-weight exhaust products. Boron is a relatively high-cost fuel which has to be justified by considerable gains in performance.

Raw material for the fuels is borax; U.S. Borax is the major producer.

Boron fuels can be produced in either liquid or solid form, depending on the mission. U.S. Borax Research Corp. currently is carrying out work under two classified Air Force research contracts for Air Research and Development Command.

One contract is for continuing research on high-energy fuels of the type slated for B-70 use. The other is for the study of boron-containing components for use in high-impulse solid-rocket propellants.

• **Big advance**—Use of liquid fuel in the Marquardt hyperjet marks a considerable advance in the field of rocket-ramjets. Earlier engine combinations employed a solid-propellant rocket propulsion unit to accelerate the ramjet to its operating velocity, when it used a liquid fuel to become self-sustaining.

Use of liquids permits the design of a controllable rocket engine which can be shut down when ramjet operating velocity is reached and then restarted when the vehicle leaves the atmosphere, or is called upon to resume rocket operation for any other reason.

The outer case of the rocket unit in the hyperjet serves as the central contoured surface of the ramjet inlet and is aligned within the inlet for proper establishment of the shockwave. The rocket unit fires through the ramjet combustion chamber and nozzle.

Flame from the rocket nozzle is used to ignite the air/fuel mixture of the ramjet engine. Ignition must, however, occur early enough to prevent overheating of the ramjet's fuel injector and flame holder by the rocket blast.

Traveling Hound Dogs

A FLYING launch pad, this Boeing B-52G Stratofortress can destroy three targets in one mission; two with the *Hound Dog* missiles under the SAC bomber's wings, and a third with the regular bombload.

15 Quit Von Braun Team To Join New Belock Facility

By Paul Means

Belock Instrument Corp.'s announcement Wednesday that the company had hired a team of 15 Huntsville German scientists headed by Dr. Frederick K. Mueller, deputy director of the ABMA Guidance and Control Laboratory, precipitated a minor storm in the space and missile field, including the following:

• ABMA issued a corollary statement that the Huntsville NASA division has received no resignation from Dr. Mueller, or from any other member of the guidance and control laboratory;

• Dr. Mueller at first denied that he had accepted the Belock offer.

• Dr. Wernher von Braun, in Washington to testify before Congress, declared that NASA's new George C. Marshall Huntsville facility which he heads as chief scientist no longer required the services of Dr. Mueller or his associates, and said he doubted that Belock's new Huntsville subsidiary would do any business with his team or the Army.

The Belock statement said the company was establishing a new facility at Huntsville called Astro-Space Electronics Corp., headed by Dr. Mueller and a "team of German-born scientists."

A Belock spokesman told M/R that besides Mueller there were about 15 other German scientists including original Von Braun team member Heinrich Rothe, Chief of the gyro and stabilizer plant of the Guidance and Control Laboratory, and his brother Wilhelm Rothe, also of the Guidance and Control Lab. Very few of those joining Belock are original Von Braun team members.

The Belock announcement said its Huntsville facility will "conduct a research and development laboratory in every phase of the guidance and control field, and is being financed by the New York firm of Karl N. Loeb, Rhodes Co. Original outlay, according to a Belock spokesman, will be $1 million.

Contacted four weeks ago by M/R about his future association with Belock, Dr. Mueller termed the story a "lie" and intimated he would sue if it was printed. Wednesday, after the Belock announcement, Dr. Mueller said he had not handed in his resignation, but that "circumstances led me to consider this offer seriously."

Contacted in Washington where he is taking time out from a vacation to appear before the House Appropriations Committee, Dr. von Braun said that the news did not come as a surprise to him. Belock and the Mueller team had been negotiating for some time, he said.

The German space scientist said Dr. Mueller and his associates were experts in gyro platforms. With the transfer of his organization from missiles to space vehicles and from the Army to NASA, Dr. von Braun said there was little need for his team to do future extensive work in this area.

He said he thought it was a mistake for Belock to establish its new facility at Huntsville, "at least if they expect to do business with us."

"We have done business with Belock," he said, "and I think it would be well to add that we have no plans to do further business in the future."

What Belock gains by hiring his ex-associates, Dr. von Braun said, was a capability in gyro-stabilizers.

EIA Hears DOD Budget Defense

The Defense Department has to make some "hard choices" but it comes up with the right answers in safeguarding the national security, a top-level Pentagon official told the Defense Market Planning Seminar in Washington.

John M. Sprague, Deputy Assistant Secretary of Defense, vigorously defended current DOD budget requirements and spending, pointing out that they have been equated with a multitude of national and international considerations.

The seminar, a prelude to the annual three-day spring conference of the Electronics Industries Association, sought answers to the problem of how to get "more defense per tax dollar." More than 400 representatives of the industry, military and government attended the two-panel daylong meeting.

Sprague said the crux of the problem within the executive branch is to strike a proper balance, in terms of priorities, among military requirements, space exploration, civilian needs, future economic growth, the tax burden, debt management, etc. The Defense Department must provide for national security —but within the available resources.

"There is no question but that the 1961 budget reflects some very hard choices. But in the judgment of the President and the Secretary of Defense the 1961 defense budget does provide for those programs which are essential to our national security."

In discussing our changing defense market, J. H. Richardson, Hughes Aircraft Co. marketing director, stated that electronics and propulsion today have taken on strikingly greater significance and in fact have become the main segment of the new military missile/space market.

Other panelists were Dr. L. E. Root, Lockheed; Dr. R. C. Raymond, General Electric; Col. E. C. Lavvier, Air Research and Development Command; and Dr. H. Wilcox, deputy director of research and engineering, DOD. Sidney R. Curtiss, Stromberg-Carlson, was Panel Chairman.

• **Other highlights**—An increase from 14 to 20% of total defense expenditures for electronics during the next 10 years was predicted by Rear Adm. L. D. Coates. This, he said, would amount to $2.4-billions of additional business for the industry. (Figure is based on a constant total defense budget.)

He also called on industry to strive more for "healthy diversification" to minimize risk and provide more stability. This spread should be in the defense market as well as the consumer market. Finally, he emphasized the need for more company-sponsored research and improved reliabilities at more sensible prices.

As evidence of the steady upswing in electronics requirements, Brig. Gen. E. L. Littell, Commanding General, U.S. Signal Supply Agency, estimated that the field army of the 60's will be equipped with over 75,000 electronic emitters—2.5 times that used in World War II.

To get the most out of its Budget, he said, requires more understanding between the military and industry. The major problem is an intelligence gap. More avenues of communication, both horizontal and vertical, are needed to better pool resources, know-how, creativity, and producibility.

"The quantity and quality of information that can be obtained from the military by any industrial firm varies directly with the quantity and quality of its effort or contribution," said RCA's Dr. N. I. Korman.

The paradox is justified, he said, because no company can expect to be merely a sponge—always seeking and absorbing without giving in return. The amount of information received on a "need-to-know" basis represents not only the degree of confidence in the company held by DOD officials, but the return the military might reasonably expect by sharing data.

Pioneer V Narrows the Space Gap

Third try with Thor-Able vehicle brings successful orbit of payload with unprecedented transmission power

The belated but highly successful launch of *Pioneer V*, March 11, helped to close the gap between the U.S. and Russia in the race for space accomplishments.

Though preceded by *Lunik I* and *Pioneer IV* into orbit around the sun, the 94.8-lb. *Thor-Able*-launched payload is man's first significant and useful planetoid.

Three major "first" to be accomplished by *Pioneer V* are:

- The first payload to send back information from outside the earth's gravitational field and to relay information from and about the solar system;
- A new tracking record (the old record was 407,000 miles by *Pioneer IV*); the payload should be able to send back receivable signals for about five months during the first half of its journey around the sun (over 250 million miles), and until it reaches a distance greater than 50 million miles from earth.
- The first payload to be placed in a solar orbit inside the earth's own orbit.

NASA announced soon after launch that the payload's instruments and transmitters were all in working order. Jodrell Bank and other larger radio telescopes were receiving strong signals.

• **Third try success**—*Pioneer V's* successful launch came after 10 months and two unsuccessful attempts. NASA originally scheduled the shot last June when Venus would have been in the most desirable location for intersection. This shot was called off because the payload was not ready. A December attempt also ended in failure.

Original intent was to place the payload in a trajectory that would take it close to the orbit of Venus at perihelion. This is a difficult feat: an error in the rocket's velocity of only one mile per hour, would have missed the orbit of Venus by as much as 60,000 miles. Actual error was 120 feet per second at burnout (36,480 feet per second), meaning that *Pioneer V* will come within 7.7 million miles of Venus' orbit.

This was the first time in three attempts the BMD-STL *Thor-Able* vehicle has achieved escape velocity. Its performance was highly accurate. First-stage burning time was within a second of normal; second-stage burning time was within a tenth of a second of normal; and third-stage burning time was also within a second of normal.

• **Instrument lead**—*Pioneer V* displayed to best advantage the U.S.'s strong point in the space race: though behind in thrust, payload weight, and possibly in guidance, the U.S. can pack more sophisticated instruments into smaller spaces.

This lead in electronics and instrumentation becomes significant on deep space missions where transmitters must be powerful enough to be received over millions of miles and instruments must take up a minimum of space.

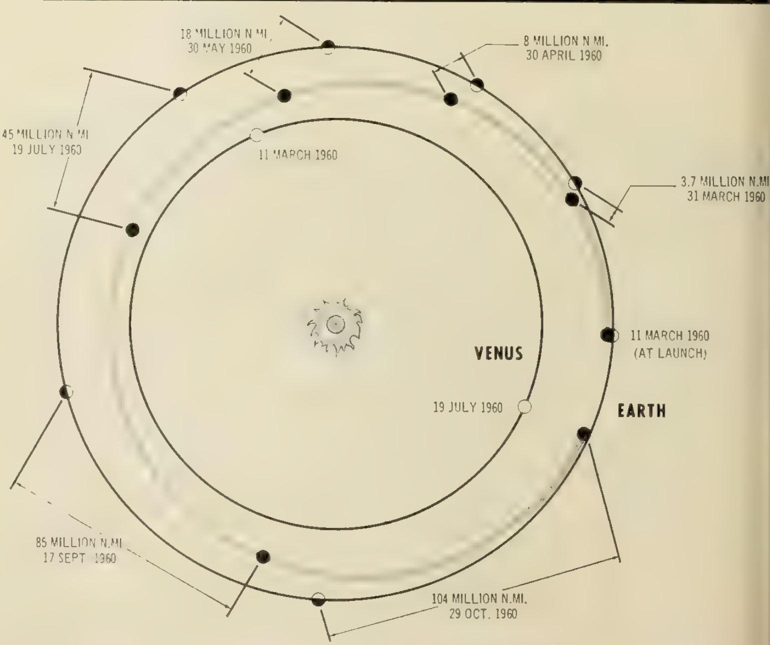
Pioneer V's payload, designed by Space Technology Laboratories and similar to the "paddlewheel" payload of *Explorer VI*, has less than 10 lbs. of structure, 40 lbs. of instruments, and close to 50 lbs. of power package and solar cells.

• **Satellite's assignments**—The 26-inch diameter, top-shaped sphere is designed to study interplanetary gas and solar terrestrial relationships. (M/R, Oct. 19, p. 33).

Studies by Van Allen in earlier earth satellites indicated that the sun emits quantities of plasma gas into the solar system, some of which is captured by the earth's magnetic field to form belts of charged particles.

A one-half pound coil magnetometer developed by STL will study these streams for fields of gas. The instrument possesses a sensitivity of at least 10^{-5} Gauss.

The satellite will also study the magnetic fields of plasma globs floating through interplanetary space and try to determine the mechanism for the propagation and transportation of plasma



FIRST SATELLITE to go into a solar orbit inside the earth's own orbit, *Pioneer V* will come within 7.7 million miles of the orbit of Venus.

streams from the sun to the earth and into the rest of the solar system.

Other duties of the payload will be to observe meteorites and dust particles in solar space outside the earth's gravitational field, and to collect data on the sun's ultra-violet and X-ray regions. The correlation of all this information should give a clearer picture of terrestrial relationships.

Long-range communication with the satellite will make possible satisfactory triangulations with the sun, which will help to make a more accurate determination of the astronomical unit.

• **Instruments**—Specific instrumentation which would perform these tasks (besides the magnetometer) are a five-pound radiation counter developed by the University of Chicago's Fermi Institute which is able to measure both high-and low-energy charged particles, an ionization chamber and Geiger-Mueller tube developed by the University of Minnesota which measures the total radiation flux encountered, a micrometeorite counter, and an aspect indicator which triggers electrical impulses each time it looks at the sun.

STL has also developed a black and white paint pattern for the outside shell of the payload which will maintain desired temperatures of between 35 and 80°F inside despite the increased radiation of the sun as it approaches the orbit of Venus.

The black paint absorbs the radiation of the sun which causes a temperature rise while the white paint reflects the radiation cooling the payload.

Helping to transmit the information received by the satellite's instruments is a compact telemetric digital unit developed by STL called "Telebit." Designed to transmit information over interplanetary distances upwards of 50 million miles, this instrument collects, stores, and tallies data while the transmitter is off, and sends the totalled information by radio signal to earth when the transmitter resumes operation. The payload instruments and transmitters are designed to last for 2000 hours of continuous transmission, and the payload will transmit about five minutes out of every five hours.

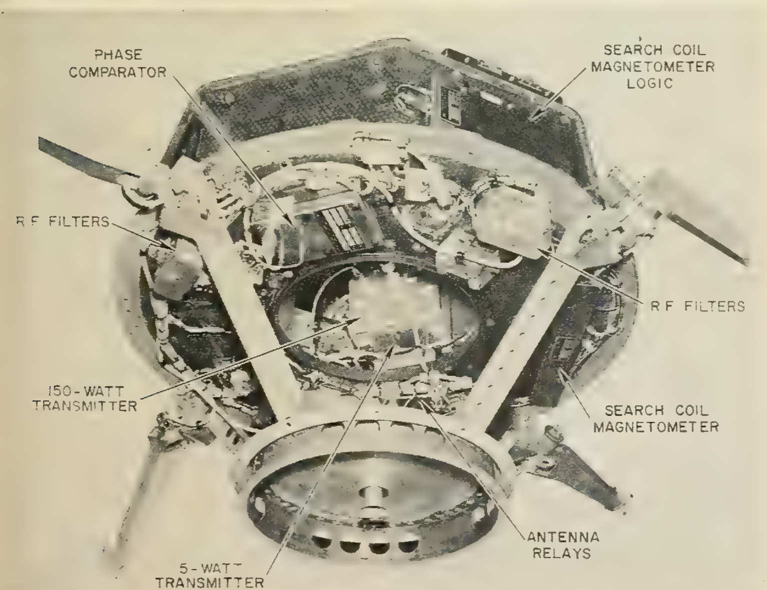
• **Potent transmission**—The great tracking distance to be achieved by *Pioneer V* is possible because its transmitting system is 30 times more powerful than that of any previous space vehicle. A five-watt UHF transmitter will function until the payload achieves a distance of about five million miles from earth. Then, upon command from the ground, it will become an amplifier for the 150-watt transmitter. Both operate on 387 MC. Lithium metal heat sinks control the transmitter's temperature.

Supplying power to the batteries and transmitters are 4800 solar cells made by Hoffman Electronics on the payload's four "paddlewheels." Though greatly reduced in number from the 8000 cells contained in *Explorer VI*'s paddlewheels, the closer distance that the payload will travel to the sun means that they should get 30 to 40% more intense solar energy.

An improvement to the *Able*'s guidance system for the *Pioneer V* shot was contributed by Space Electronics Corp. Under subcontract to STL, they produced a lightweight radio transmitter 10 times lighter than equipment previously available.

Pioneer V Data

Weight: 94.8 lbs.
Perihelion: 74,967,000 (Aug. 10)
Aphelion: 92,358,000
Period: 311.6 days
Orbit Path Length: 514,500,000
Mean velocity: 71,400



PROBE PAYLOAD of *Pioneer V*, with aluminum shell stripped away, looks like this. Near the earth, 5-watt transmitters is used; later, 150-watt unit takes over.

—news briefs—

FIRST FIRING SUCCESS—The Navy fired a test version of its *Corvus* air-to-surface missile in its first guided flight at Pacific Missile Range March 15, and reported that it was completely successful. The Temco missile was launched from an A3D jet at a surface target in the sea test area of PMR. Navy recently awarded Temco a $25-million contract for continued work on the missile, which uses a prepackaged liquid rocket engine.

WAYWARD BIRD—An Air Force *Matador* veered off course in a test firing and crashed into Formosa Strait near the Red Chinese Mainland, a military spokesman disclosed. He said the firing took place in January.

IRBM's IN ITALY?—*Jupiter* IRBM's were reported in Rome to be already installed "somewhere in Italy." U.S. plans call for turning over two 15-missile squadrons of *Jupiters* to the Italians.

AICBM DEBATE—Dr. Herbert York, Pentagon R&E Chief, said many top defense officials have "considerable doubt" that the *Nike-Zeus* antimissile missile will ever be able to discriminate between decoys and incoming warheads. The Army has insisted that *Zeus* will be able to pick out warheads.

SWITCH URGED—Deputy Defense Secretary James H. Douglas told the House Space Committee that the Civilian Military Liaison Committee should be abolished and an Activities Control Board put in its place. The main difference would be the elimination of a chairman.

RENAMING — President Eisenhower named the new NASA facility at Redstone Arsenal, Ala., for the late General of the Army George C. Marshall. The former ABMA Development Operations Division will be known as the George C. Marshall Space Flight Center.

COMPLAINTS TO BE HEARD—A House Government Procurement Subcommittee will hold hearings March 29-31 on charges by small firms that they are forced to give up trade secrets and technological data because Defense Department contracting officers allegedly require the information.

Republic Takes Out Space Insurance

Company meets stiffer requirements and competition for defense orders by building $14 million worth of R&D labs

by William Beller
M/R Contributing Editor

FARMINGDALE, L.I.—In May, Republic Aviation Corporation will dedicate a $14-million Research and Development Center at its headquarters here. Within five years the company expects to be putting $21 million more into the facility for salaries and additional equipment.

Republic is making this large investment in itself as insurance that it will continue to get Defense Department business.

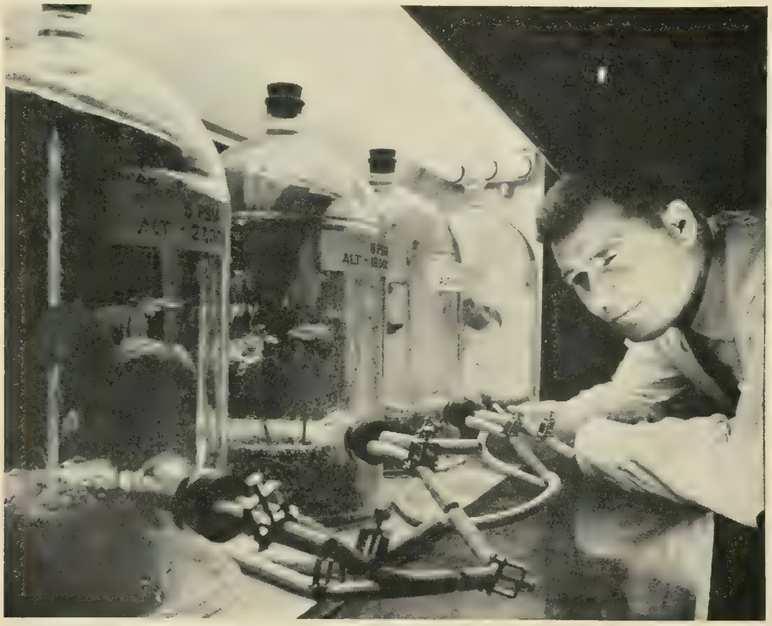
Republic's way is just one means of buying such insurance. Other companies with different management philosophies see other ways. Some buy concerns outright to fulfill capabilities the parent company lacks. And, of course, there are purchases of controlling interest, mergers, joint proposals, or promises of subcontracts to highly knowledgeable cooperating companies.

Whatever the method, this much is clear: major defense contractors from now on will be continuously broadening their scope and lengthening their view—or they will no longer be major contractors.

This is a change from the way things used to be. During World War II, in the flush of the mass production of aircraft, R&D was considered time-consuming and costly. "Besides," said a then prominent aerodynamicist, "how much more performance can be squeezed out of an airplane?"

With the help of the engine manufacturer, the propeller manufacturer, and wind-tunnel reports from the National Advisory Committee for Aeronautics, the airplane designer had a fairly easy life. R&D took only a small part of his worry and the weapon dollar.

Today, in the instance of the *B-52* —which probably will be the last mass-produced large military airplane—we are experiencing R&D costs that have shot up to 20% of the weapon dollar.



IF ASTRONAUTS are going to stay long on the moon, they may have to raise their own food. Anticipating such a need, Republic has turned to raising carrots, beets, snap beans and turnips in a low-pressure "lunar greenhouse."

In the missile field, R&D costs skyrocket. For the Convair *Atlas* ICBM, they amount to about 60% of the missile's cost. When we look at space systems, we see the hardware costs of the Project *Mercury* capsules probably amounting to only 10%, of the money allocated. The 90% goes for R&D.

• **Expand or quit**—in 1958 the handwriting on the wall was clear to Republic, as it was to other companies who wanted to stay in the defense field. Since the end of the Korean war, Department of Defense annual expenditures for R&D had risen about a billion dollars: $1.4 billion spent in Fiscal 1953; $2.4 billion estimated for Fiscal 1959.

The direct stimulus for Republic's R&D expansion came from two factors: (1) the Air Force's "Weapon System Requirement Studies" plan, and (2) a flood of competitors from non-aircraft companies.

Under the Air Force's new plan, the service in 1956 began demanding studies in depth as a preliminary to contract negotiation for advanced weapon designs. This meant that a company must now show a weapon system capability before a contract was awarded rather than after, which had been the practice.

The military's reason was plain. Large-scale aircraft production was falling while missile and space vehicle work was rising fast. Novel and untried weapons systems were being proposed. The least that could reasonably be asked were feasibility studies on the part of the manufacturers.

The high cost and short life of space hardware demanded a high probability of success. This was more reason for much pre-contract study. The result was that the contractors were going to play heavier and more responsible roles in weapon system development.

• **New faces**—Republic knew that to remain vital it must also recognize many new faces. In the 1950-53 period, the company counted only nine major competitors in the aircraft and missile field. In 1958 the count was pressing 40. It was easy to see why.

The missile and space field with its problems of guidance, communications, and telemetering was fertile ground for electronics concerns. The propellant field was welcomed by major chemical concerns. Ground support equipment was of high interest to automotive companies—and such interest could be easily expanded to encompass the vehicle.

Competition came from organizations that wanted to diversify and felt that on the frontiers of technology they could more easily stake out their claims. Universities with academic talent were entering the picture, and also non-profit organizations whose claim to consideration, among others, was "objectivity."

It was true that the aircraft abilities developed by Republic over the years would hold the company in good stead competitively. Rapidly, though, novel problems were coming up. These were ones unfamiliar to the aerodynamicists, to the stress analysts, to the systems designers. These were ones in human factors calling for psychologists and physiologists, in radiation studies calling for nuclear physicists and applied mathematicians, in space exploration calling for astrophysicists.

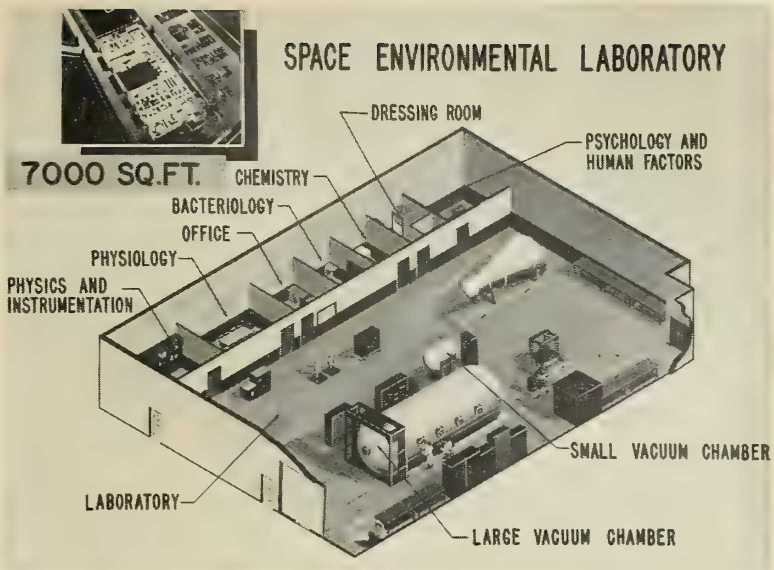
Where such specialized talents were needed, small companies often had the advantage. The owners were usually the experts; they needed only small capital investments; they were well known in their field, knew their field well, and could concentrate on developing segments of studies that major companies were ignoring.

Thus there arose scores of organizations in operations research, systems analysis, human factors, and applied mathematics. Also there was an avalanche of new firms entering the electronics field. Here in many instances only a moderate investment was needed, especially for one-product companies. These incidentally, could eventually get R&D money to grow on.

• **Fast start**—It was in such a climate, in 1958, that Republic proposed to its board of directors that an R&D facility comprising several laboratories be built. The idea was unanimously approved and money appropiated. Spark-plugging the effort were company president Mundy I. Peale and R&D vice president Alexander Kartveli.

Each laboratory was designed to be able to solve one major set of Space Age problems. The group of laboratories, each contributing its knowledge to weapon system studies, proposals and contract fulfillment, could enhance considerably Republic's defense capabilities.

Each of these laboratories would be seeking R&D contracts for itself.



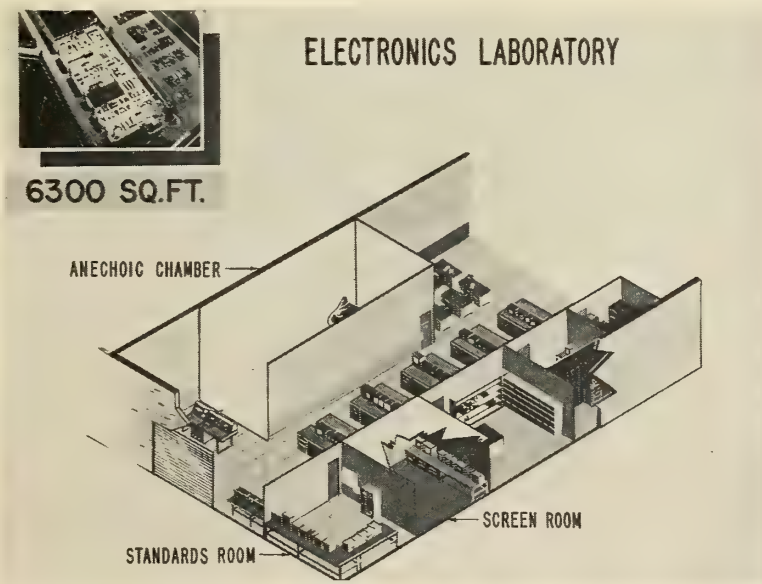
FOR SPACE environment and life sciences studies, the laboratory features a large vacuum chamber which is able to test men up to a simulated 100 miles' altitude, and equipment up to 150 miles.

Republic wants these units to be competitive with all companies, small or large. Only in this way can the parent company be assured it is abreast of modern technology, that it has the most recent data in its contract proposals and, perhaps, that it has a research laboratory paying its own way.

To compete effectively with the smaller companies, each laboratory is being staffed only by highly qualified personnel. They will have professional working conditions, will be given the latest laboratory test equipment, and will be encouraged to do original research that will promote the broad objectives of defense.

The company freely admits that its major research effort is contract-directed. Basic research—research whose sole purpose is to push back the boundaries of existing knowledge—is felt to be more appropriate to an academic atmosphere.

Suiting the deed to the belief, the company this past January gave 25 acres of its Farmingdale land to the Polytechnic Institute of Brooklyn. On



ANECHOIC CHAMBER will be used for antenna work, the screen room for noise-free testing, and the standards room for referencing electronic measurements.

RESEARCH AND Development Center costing $14 million will be dedicated by Republic in May. The two-story front is for offices, one-story rear for seven of the eight laboratories.

this site the college will build a research center for 1000 graduate engineering students and faculty.

With these men so close to Republic's new Center, it is certain that basic research will be inoculating applied research, to the advantage of each. In addition, advanced studies by Republic engineers and scientists will be a matter only of walking across the yard to classes.

The company is determined to be a major supplier in the aerospace field. It eschews any suggestion to diversify out of it. "There's a lot of space to explore," an engineer said, "so why should we dilute our efforts?"

• **Three markets**—over the next several years Republic will be looking for its business in three directions: aircraft, missiles and spacecraft. This is considered a safe and logical way for the company to proceed.

Its experience in the aircraft field led to the development of the much-applauded F-105 fighter-bomber, the Thunderchief. Second and third generation F-105s are being developed and the company has an intensive V/STOL program going on with Air Force contracts in mind.

The company is also making a systems requirement study for the Air Force of supersonic cargo transports. Out of this work Republic sees a chance to enter the commercial field for the first generation of supersonic airliners.

The company's Missile Systems Division is seven years old and in terms of work load is already mature. The largest contract is a $30-million one from the Army Signal Corps for a supersonic surveillance drone. Now being contemplated are an air-to-surface ballistic missile family, an anti-ICBM system, and development of antisatellite missiles.

In the spacecraft field, Republic is launching studies for the conventional miracles: vehicles for circumlunar missions, moon exploration, space platforms, and interplanetary vehicles.

We have a picture then of Republic Aviation stocking up on all the ingredients basic to the Space Age, but at the same time ordering fresh aircraft types for the more pedestrian but paying customers.

The guide line for the Research and Development Center was to keep it versatile and flexible. It had to be able to adapt easily and quickly to changing requirements in accord with a fast moving technology. The rule then was to invest in adequate but not elaborate facilities but be ready to build around a stable nucleus should an occasion call for it.

In its choice of laboratories for the Center may be read Republic's emphasis and also where the company feels her future lies. There are eight:

Space Environment and Life Sciences.
Re-entry Simulation.
Materials Development.
Nuclear Radiation.
Electronics.
Guidance and Control.
Fluid Systems.
Wind Tunnel.

The Center building is 500 ft. long by 150 ft. wide. It is two stories in front, one in back. The front of the building, having 67,500 square feet of floor area, will house the administrators together with the engineers and scientists not needing laboratory space.

In the rear of the building there will be 53,500 square feet of floor for the laboratories. There will be about 375 professional people in the building and 75 non-professionals.

• **Space Environment and Life Sciences.** Space conditions will be simulated for studies of man, materials and components. For testing men, laboratory equipment will duplicate pressures equivalent to those up to 100 miles above the earth's surface; and for testing materials and components, up to 150 miles. Effects of radiation on materials and components will be studied by exposing the vacuumized chamber to X-rays.

• **Re-entry Simulations.** A plasma jet system able to hold continuously 27,000°F will be duplicating temperature conditions existing during re-entry. A Mach 20 wind tunnel reaching 18,000°F will be used for studies in heat transfer, gasdynamics and hypersonics. Provisions are also being made for experimental work in magnetohydrodynamics.

• **Materials Development.** This laboratory will be studying the behavior of materials placed in drastic environments. Typical work will be (1) developing a surface treatment that will enable skin materials to withstand the rigors of rapid re-entry; (2) determining effects of precipitous temperature changes such as those that could arise in a space flight; and (3) learning properties of proposed new materials.

• **Nuclear Radiations.** With facilities that include two high-capacity hot cells with cobalt source, scientists will be studying radiation effects on materials, fluid power systems and electronic components. A low-level radiochemistry unit and counting room will be used for work in isotope utilization, basic dosimetry and general measurements.

• **Electronics.** Besides looking into systems being developed for company projects, the engineers will be working on vertical take-off (VTOL) blind landing systems, interspace communication systems, and advanced instrumentation. There will be on hand, besides standard equipment, an anechoic (anti-echo) chamber for antenna studies, a screen room for noise-free measurements, and a primary frequency standard accurate to 1 part in 10^{-8}.

• **Guidance and Control.** This laboratory will be testing existing guidance system components. It will also be developing new navigation and guidance aids for aircraft, missiles and spacecraft. Further, it will be evaluating optical and infrared detection and reconnaissance systems.

• **Fluid Systems.** This laboratory will make studies and component developments in advanced fluid systems, liquid and gas, for application to high-performance craft.

• **Wind Tunnel.** The tunnels will give aerodynamic data, including flutter, to the designers. There will be two blowdown units operating, one for supersonic work and the second for transonic. This laboratory is adjacent to the Center.

Neither the laboratory facilities nor their programs are rigid. If they were, the purpose of the Center would be defeated.

Nuclear Rocketry: How Are We Doing?

Upcoming Congressional hearing may result in calling in industry to speed development

by Jay Holmes

Controversy over the timetable and the means of developing America's first nuclear rocket—muffled until now by security classification of the pertinent facts—should break fully into the open this week. Further, there's the possibility that an industry contractor will be brought in to speed development.

At stake in a hearing before the Joint Congressional Atomic Energy Committee March 24, is a propulsion system capable of carrying a crew of explorers to the moon—and perhaps later to Mars and Venus. The specialists agree that nuclear propulsion systems will be lighter and less expensive than chemicals for carrying heavy payloads, for traveling long distances or both.

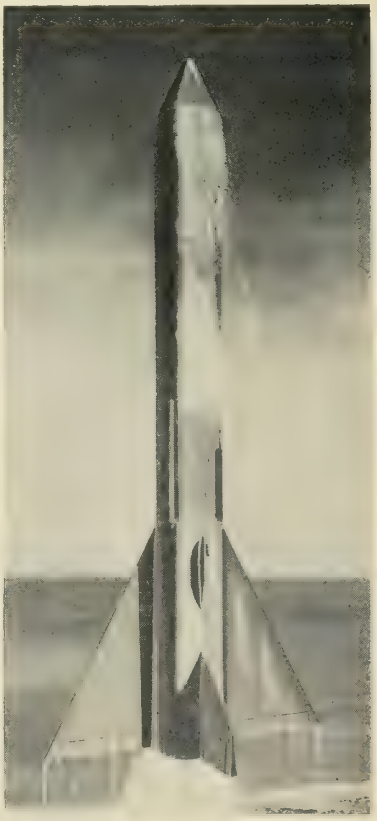
As the struggle behind closed government doors gradually emerged into public sight last week, three viewpoints became apparent. Those choosing sides in the debate are lining up behind:

- A high-gear program to fly a nuclear rocket as soon as technology will allow—backed by many Atomic Energy Commission officials and Sen. Clinton P. Anderson (D-N.M.), chairman of the Atomic Energy Committee. Anderson has proposed bringing in an industrial contractor soon.
- A program calling for full-speed ground testing but a more cautious approach to flight testing—favored by some officials of the National Aeronautics and Space Administration.
- A slowdown—proposed by the Bureau of the Budget.

Two high AEC officials close to the nuclear rocket program—Brig. Gen. Irving L. Branch and Col. Jack L. Armstrong—have said the AEC could develop nuclear propulsion for a manned moon expedition in less than 10 years if such a requirement were given them. Armstrong said he spoke in terms of a 20,000-lb. payload.

Two NASA officials—Deputy Administrator Hugh L. Dryden and Harold E. Finger, chief of nuclear engines, have reported their agency wrote to the Budget bureau urging that AEC be permitted to conduct ground testing as fast as technology allows. However, Dryden said a manned moon expedition would be impossible in this decade regardless of progress in propulsion. Solving the problems of re-entry from a lunar distance will take longer than 10 years, Dryden predicted.

Budget Bureau officials maintained their customary silence. However, word got out that the bureau softened its slowdown stand following an appeal by AEC Chairman John A. McCone.



CONVAIR'S Krafft Ehricke's concept of a spaceship powered by a nuclear rocket.

The controversy over the nuclear rocket—Project *Rover*—was brought into the open by Sen. Anderson a week before his committee held a closed hearing Feb. 15. He issued a statement after the first hearing and more facts came to light when the House Committee on Science and Astronautics took open testimony Feb. 26. Still more are expected when the Atomic Energy group holds its open hearing on *Rover* Thursday as part of a four-day series, "Frontiers of Atomic Energy Research."

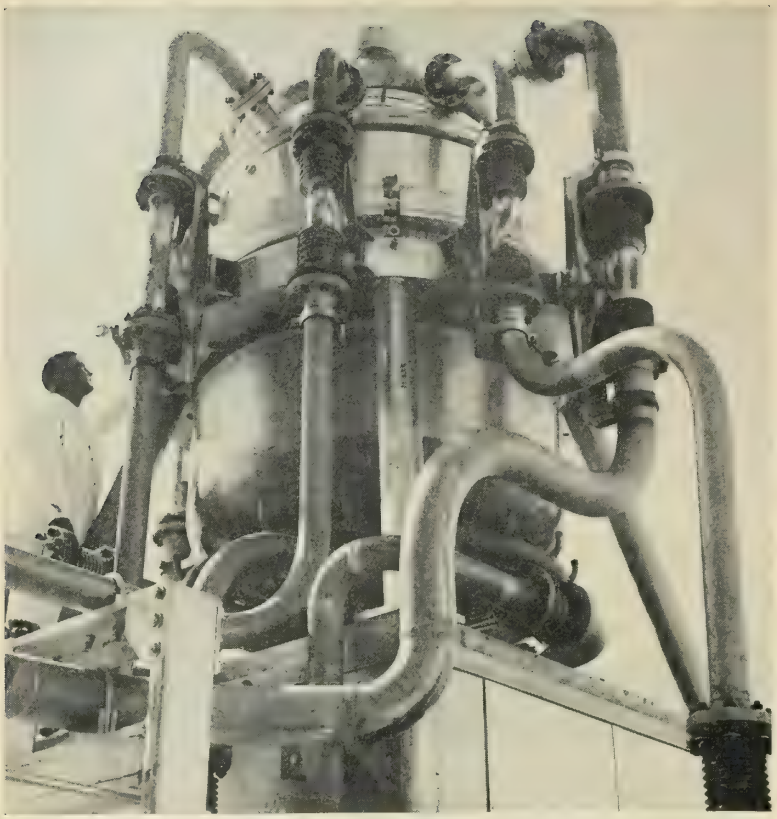
Sen. Anderson has proposed that, to speed the *Rover* development, complete responsibility be assigned to the AEC through the flight test phase, an industrial contractor be brought in soon to work with the AEC's Los Alamos Scientific Laboratory and the first flight test be scheduled for 1964 or as soon as possible thereafter.

• **Technical controversy**—In addition to the political dispute over funding and schedule, a second argument—largely technical—has nuclear propulsion experts divided. This latter dispute concerns the nature of the first flight test—likely to be conducted in the mid-1960's. One group favors a direct launching from the ground. Another group prefers that the first test be from orbit.

In general, AEC officials prefer ground launching while NASA's tend to favor orbital start. However, neither agency is unanimous.

Although discussions center on technical points, the argument is by no means purely technical. The AEC's Armstrong maintains stoutly that ground launching is the surest way to the first accomplishment of a feat that he says will command tremendous international prestige—the first nuclear-propelled flight in space. "I'd like to see the Stars and Stripes on this one," Armstrong told the Science and Astronautics Committee.

NASA's Finger contends that in the long run more prestige will come to the



CLOSEUP OF the experimental model of America's first nuclear rocket engine, ***Kiwi-A*****, before its first full-scale test at Jackass Flats, Nev.**

nation that accomplishes experiments more nearly related to the eventual scientific use of a nuclear rocket. "I think the first practical use of a nuclear rocket will be as an upper stage of the *Nova* vehicle," Finger said.

Armstrong, deputy chief of the AEC's Aircraft Nuclear Propulsion Office, has proposed the construction of the first flyable *Rover* by the mid-1960's. AEC calculations call for a bird weighing 40,000 lbs., with a rocket generating 52,000 lbs. thrust at liftoff and continuing for more than five minutes. The device would carry a 1000-lb. scientific payload to an altitude of about 1000 miles. Unprotected by a nose cone, the vehicle would be destroyed upon re-entry into the atmosphere.

Finger said he believes the first nuclear rocket can be flown just as quickly if it is started from orbit. But even if the orbital flight plan should cause a delay of as much as a year, the NASA official said, he still would prefer it.

• **Project review**—Sen. Anderson reviewed the history of Project *Rover* in a statement he issued at the close of the Feb. 15 hearing. He reported that:

• The project began in 1955 as an AEC-Air Force program, with a 1960 target date set for completion of the engine's feasibility ground tests. In 1957, Secretary of Defense Charles E. Wilson downgraded *Rover*'s priority, reduced its projected funding level and stretched out the time schedule. The feasibility ground tests were rescheduled for 1963.

• The AEC successfully conducted its first test of a reactor device for *Rover* last summer.

• This winter, the program was stretched out again. At the instance of the Bureau of the Budget, President Eisenhower moved the feasibility test back to 1964. Funds requested by the AEC for the 1961 fiscal year were reduced by $12.8 million—about 31%. Mr. Eisenhower's 1961 budget called for $28.5 million for nuclear rocket propulsion—$23 million for the AEC and $5.5 million for NASA—which had taken over the original Air Force role of responsibility for developing non-nuclear components of the vehicle.

NASA announced at about the same time the broad outlines of a 10-year program of expected progress in rocketry. The program included no mention of a nuclear rocket. NASA spokesmen said it was not included because they did not feel sure an operational nuclear rocket could be developed within a decade. The first launching of the *Nova* booster—with its six to nine million lbs. of chemical thrust—was set for fiscal 1968 with two more the following year.

Anderson said before the hearing that he had believed *Rover* would be speeded as a result of last year's successful experiment. "But instead," he said, "we seem to be moving into a period of stretch out, indecision and drift comparable to the aircraft nuclear propulsion project."

The senator said the committee's examination would include the effect of security classifications.

"I have difficulty seeing how this project can be classified when the military have set no requirement for it and NASA does not even mention it in its 10-year program," he said.

Following the first hearing, committee sources said AEC officials defended the security classification on the ground that America still seems to be ahead of the Soviet Union in nuclear technology.

However, the *Rover* development schedule was declassified in part. Anderson reported that the Budget Bureau had increased its spending authorization for *Rover* in Fiscal Years 1961 and 1962 after an appeal by AEC Chairman McCone. However, no more money was allowed. The AEC had requested $20 million for construction in the 1961-62 fiscal years. The Budget Bureau cut this to $13 million. After the protest, the AEC was told that the other $7 million might be shifted to *Rover* by re-programing.

On March 8, Anderson made public a letter from John F. Floberg, acting AEC chairman, disclosing that the commission had reprogramed to add $8 million in construction funds and $3 million in operating money to *Rover* for fiscal 1961.

For the construction funds, $4.4 million was taken from Eniwetok Proving Ground construction, $1.9 million from the Tonopah Test Range in Nevada and $1.7 million from additions to the electrical power system at the National Reactor Testing Station, Arco, Idaho. The operating funds were taken from the Euratom program.

At the Science and Astronautics Committee hearing Feb. 26, NASA's Dryden and Finger testified they had supported the AEC's proposed schedule in a letter to the Budget Bureau. Afterward, MISSILES AND ROCKETS asked Finger whether NASA had supported AEC's request for the funds necessary to carry out the schedule.

"No," he replied. "We did not feel it was up to our agency to say whether the AEC budget should be $2.6 billion

or $2.61 billion."

• **Transfer considered**—Sen. Anderson has said the Joint Committee on Atomic Energy will consider whether *Rover* should be transferred entirely to the AEC.

"I frankly doubt that very effective administration of a project of this nature can be achieved through policy direction provided by an inter-agency coordinating committee," Anderson said in letters to McCone and NASA Administrator T. Keith Glennan. "I believe that one man and one staff should provide the overall project direction as has been done with the case of the nuclear submarine under Vice Admiral (Hyman G.) Rickover . . .

"But the most important thing to get this project 'off the ground' is that there must be a genuine sense of enthusiasm and urgency at the highest levels to give impetus to the project."

Anderson said he was heartened by the AEC's support of the project, "I only wish," he added, "that the rest of the Executive Branch, and particularly NASA and the Bureau of the Budget, would show a greater interest."

What is the mission of a nuclear rocket? The first point that must be made clear is that nuclear propulsion is justified primarily by its potential capability of delivering large payloads, of traveling long distances, or both.

Industry points out that if you think big in space travel, you must think in terms of nuclear propulsion. A nuclear reactor and its shielding make up a very large item, both of weight and cost. But as space vehicles grow larger, the time must come when the savings in propellant consumed will more than make up for the cost of the reactor system.

A nuclear reaction releases a tremendous amount of energy—millions of times as much as in the most furious chemical reaction. If we could convert all or even a large part of this energy to useful thrust, the nuclear rocket would provide specific impulses hundreds or thousands of times as great as for chemical systems.

One program in progress shows good promise of converting nuclear energy into useful thrust. Project *Orion*, conducted for the Advanced Research Projects Agency of the Defense Department by General Dynamics Corp., envisages a vehicle propelled by a series of low-yield nuclear explosions.

However, Project *Orion* is in a very early study stage. No one has yet developed a plan for early construction of such a vehicle. Also, testing might run afoul of an international ban on nuclear bomb testing.

Project *Rover*, however, takes a more conventional approach. The rocket will carry a large tank of liquid hydrogen, which will be boiled to a gas, heated by passage through the bowels of a nuclear reactor and expanded through a nozzle. The nozzle will be regeneratively cooled by the liquid hydrogen.

The AEC calculations of the *Rover* nuclear rocket's specific impulse are classified. However, nuclear scientists have published assumptions in the 700-800 second range—compared with 300 seconds for the LOX-kerosene combination in the *Saturn* and F-1 chemical rockets.

At a specific impulse 2½ times as great, it is obvious that much less propellant will be required for a specific mission with a nuclear rocket than with a chemical rocket. On the other hand, the nuclear reactor and its shielding will weigh more than the auxiliary hardware required by the chemical rocket.

Thus, for smaller tasks, the chemical rocket is more practical. But as we increase the size of the desired payload, the size of the fuel tanks, pumps and other equipment increases in steady proportion. A three-stage vehicle based on the six-million-pound-thrust *Nova* cluster would stand as tall as a 24-story building. For fuel alone, the cost of launching 50 tons might run into the millions of dollars. For the many tests

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required to develop reliability in the vehicle, the cost is fantastic.

In the case of the nuclear rocket, however, the weight and cost of auxiliary equipment do not increase so rapidly. A reactor should not double in weight each time we double its output. As a matter of fact, if better materials can be developed, it may be possible to increase the output of a reactor with little or no increase in weight.

As we increase the total impulse of a nuclear rocket, we must increase the propellant supply. But since the specific impulse of a nuclear rocket is greater, the amount of propellant required rises more slowly than in a chemical rocket. Since the reactor weight remains relatively stable, the payload fraction of the nuclear rocket steadily increases as its size increases, while that of the chemical rocket remains stable.

• **10 years for crossover?**—The specialists are far from agreement on when the crossover in favor of nuclear propulsion is likely to take place. It is certainly a decade away. And it depends on such imponderables as how fast the overall space program will actually progress in the 1960s.

The first truly economic nuclear-propelled vessel might be a spaceship to carry a fairly sizeable crew of explorers to the moon. Or a smaller group to Mars or Venus.

Meanwhile, however, smaller vehicles must be built to test the concept in operation. The first will obviously be based on *Kiwi-A*, the nonflying prototype engine tested successfully last July 1.

This is the nub of the flight-test dispute: A series of ground tests, including the second scheduled for next summer, is to be completed by 1963.

Next comes the construction of a flyable rocket in a time not specified but apparently about two years. Armstrong would launch from Eniwetok, a Pacific island where the AEC has extensive facilities for nuclear bomb testing.

Finger notes that the projected development timetable for Project *Saturn*, the space vehicle based on the eight-engine cluster with 1½ million lbs. of thrust now under development at the new NASA facility at Redstone Arsenal, Ala.

By 1965, Finger points out, the booster should have developed a high degree of reliability and the powerful liquid hydrogen-burning upperstages should be available to propel the heavy nuclear rocket into orbit.

The NASA official feels the rocket should be started in space, after its orbit has been stabilized. The primary reason, Finger said, is that such a test is closest to the actual early mission of a nuclear rocket.

• **Safety**—A second reason is the question of safety. "We take a cold reactor in orbit," the NASA official declared. If it fires, it goes farther out. If it doesn't, it is still cold and relatively harmless."

Finger said the hazard of possible atmospheric contamination is a factor weighing against a ground launching, although not a primary one.

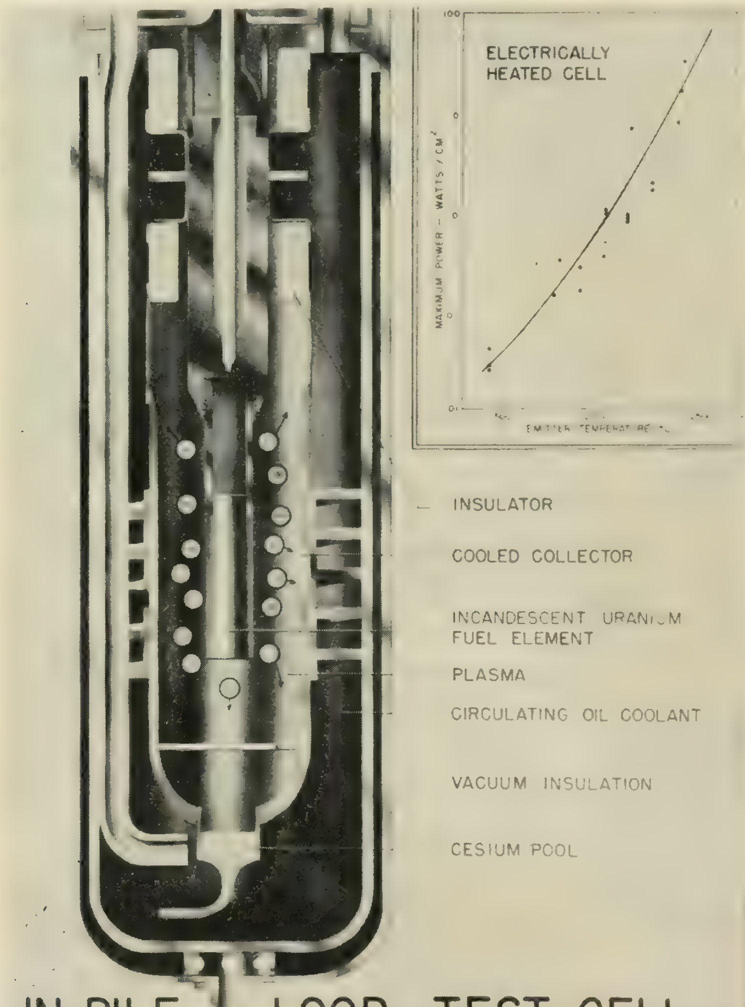
All the specialists agreed that the amount of atmospheric contamination caused by a *Rover* launching would be a tiny fraction of the contamination caused by a small nuclear bomb.

The primary question, Finger declared, is to design an experiment that will provide a maximum amount of information, and speed development to the maximum. "Let's try to design a program so that we can do a useful mission with it the first time," he said.

Armstrong maintained that a start from orbit is the most difficult way he knows to test a reactor device. It must be operated completely by remote control. Furthermore, the low level of knowledge about conditions in space makes it impossible to anticipate all the conditions that exist in orbit.

Nevertheless, Armstrong said, there are some reactors that should only be started from orbit—for instance, a SNAP II reactor, designed to provide auxiliary power in a space vehicle. "To all intents and purposes, this is an inanimate object at launching," he remarked. "We want to have the orbit stabilized and determined to be correct before we start the reactor."

Armstrong argued that the major consideration is the prestige value of



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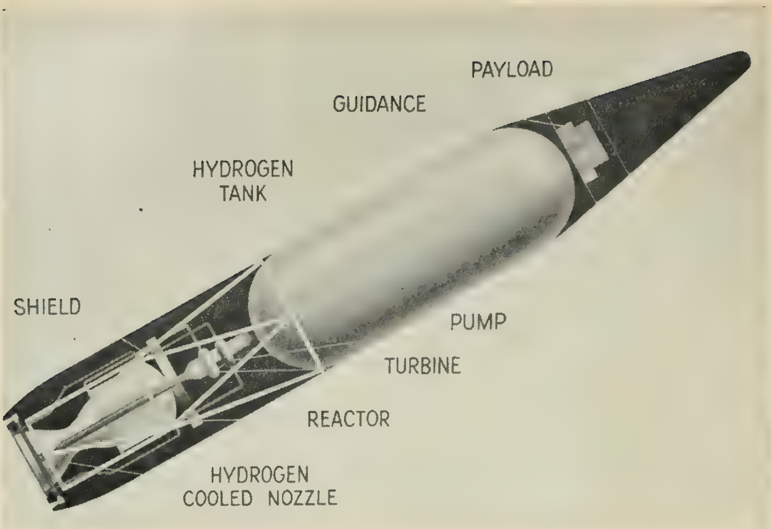

SCHEMATIC SHOWS typical components of a nuclear rocket.

sending the first nuclear-propelled vehicle into space. It isn't just a stunt, he said, because the first flight would be a small model of the ultimate primary mission of nuclear propulsion. It will have all the major components of a space ship—reactor, shielding, hydrogen tank and payload—and will lift from the ground in the same way.

• **Shielding**—Since shielding on the first flight must be kept to a minimum, he said, equipment in the scientific payload would have to use tubes instead of transistors. Also on the subject of shielding, he noted that some would be necessary in any case to protect against Van Allen radiation. Not much more is needed to shield against the reactor, he added.

To help settle the issue, NASA plans to have a study of all aspects of the problem made by an industrial contractor. Finger said he hopes to circulate bids on the study within a month or two. The contract would be awarded about a month afterward, and the study would take from six to nine months.

The contractor will seek to learn what type of test program will provide the most meaningful results in terms of development of the rocket. "The study may not provide us with the answers," Finger said, "but it will give technical information on which it will be possible to base judgments."

He said the cost of the study would be paid with Fiscal Year 1960 funds. He declined to estimate how much would be involved.

Shielding is of course but one of a host of technical problems that must be solved in designing a nuclear-propelled vehicle. Actually, it may be one of the easiest. Everyone's design of a nuclear-propelled vehicle calls for reactor and rocket in the rear, a large liquid hydrogen tank in the middle and payload in the nose.

Since the vehicle is long and narrow, the distance between reactor and payload tends to reduce the intensity of the radiation. In addition, the hydrogen tank and its contents act as a very effective shadow shield.

In the reactor itself, the problems are not so easily solved. First and foremost is a need to develop a reactor that operates at a much higher temperature than usual. The temperature of a reactor varies according to its application and its specific design characteristics. A typical temperature for a power reactor on the ground might be in the neighborhood of 1200°F. To develop specific impulses in the range of 700-800 seconds, using hydrogen as the propellant, the temperature must be brought up to the range of 2700°-4500°F.

However, even if the temperature cannot be brought quite that high, there is still a performance gain over chemical systems. Dr. Raemer E. Schreiber, who heads the scientific group working on *Rover* at the AEC's Los Alamos Scientific Laboratory, has calculated that hydrogen propellant has a specific impulse of 400 seconds—the top figure for a chemical reaction—with a nuclear reactor operating at only 660°F.

Specific impulse increases with the square root of the absolute temperature of the exit gas. Thus the performance increases with temperature. Specific impulse also increases in inverse proportion to the average molecular weight of the exit gas. This is why hydrogen, the lightest element, must be chosen as the propellant.

At a specific impulse of 800 seconds, Schreiber said in an article in the Fall-Winter edition of the Air University Quarterly Review, about 20 kilowatts are required to produce a pound of thrust. Thus, he said, a 50,000-lb. thrust engine requires about 1000 megawatts of power. In his testimony before the House committee, Armstrong said the latest AEC calculations called for an engine with 52,000 lbs. thrust for the first test.

The biggest reactors in existence on the ground put out less than 1000 megawatts. The largest in this country, the Dresden Nuclear Power Station, started up at Morris, Ill., last year by Commonwealth Edison Co., will have a maximum output of 626 thermal megawatts. The reactor for the nuclear ship Savannah, to be started this year, will put out 69 thermal kilowatts. Nuclear submarine reactors have about the same capacity.

A nuclear rocket big enough to lift a 750-ton space ship must develop upwards of two million lbs. of thrust. Hence, it requires a reactor that generates about 40,000 megawatts, more than 40 times as much as the most powerful reactor in existence today. This gives an idea of the advances in technology necessary before the nuclear spaceship can be flown. It makes clear why the most optimistic estimates of the timetable are in excess of 10 years.

• **Third possibility**—In addition to ground launch and orbital stage, there is a third possible method of testing a nuclear rocket: as an upper stage, started on the ground but not put in operation until the chemical stage burns out.

Finger says there is no consideration of a test of this sort at first because the first nuclear rocket developed would not be of a size that would be easy to mate with an existing chemical booster.

However, some in industry have been suggesting combinations. There is some talk, for instance, about the possibility of using a *Titan* first stage to lift the nuclear stage above the atmosphere.

In flight testing such a device, a trajectory would be chosen such that, if the nuclear rocket failed, it would just fall into the ocean. This would be a relatively harmless inventory of U^{235} in a non-critical configuration.

If it should fail on leaving the atmosphere, it would probably burn up on re-entry. Thus the absence of a suitable nose cone is protection for those below.

As for the in-between case, where the reactor starts too slowly and stops within the atmosphere, the amount of

fission produced would be small. This is because the amount of fission products varies with the power level and time at which the reactor operates.

• **Hybrid nuclear** — Krafft A. Ehricke of General Dynamics' Convair Division has been plumping for an interesting hybrid nuclear-chemical engine that may combine the advantages of the nuclear booster and the nuclear upper stage lifted by a chemical booster.

Ehricke's design calls for two liquid hydrogen-LOX booster engines that would give the overall system initial velocity, fed by a relatively small ring-shaped lox tank. When the LOX runs out, at an altitude of 120,000 to 140,000 ft., the booster would fall off, just as the *Atlas* booster engines. Then the hydrogen flow would be directed through the reactor for the remainder of the mission.

At last month's National Missile/Space Conference in Washington, Ehricke declared that a choice must be made soon between chemical and nuclear propulsion for the generation of booster rockets after *Saturn.*

Ehricke said a decision should be made this year on whether to push Project *Rover* or Rocketdyne's 1½-megapound F-1, which is designed to be clustered into a booster generating between six and nine megapounds thrust. The development schedules for the F-1 and *Rover* make them closely competitive. However, the F-1 is funded for $41 million in President Eisenhower's 1961 budget, almost double the $23 million in the AEC budget for *Rover.*

The overall total for chemical rocket development by NASA alone is $390 million, more than 13 times as much as the AEC-NASA total for nuclear rocket propulsion.

• ***Rover* schedule**—What is the *Rover* test schedule? "This is not a crash program," says Armstrong. "It is moderately paced by the degree of success. Between experiments, there is construction to do."

Armstrong says the first experiment last summer, which was designated *Kiwi-A,* "proved to us we were on the right track."

Another test is scheduled for the coming summer. It will be designated *Kiwi-A*-Prime. "We shall probably ask many of the same questions," Finger said. "Many more reactor tests will be required, to supply much necessary data," the NASA official declared. "We are hoping to move rapidly. We need money, but that is not all."

If the program were to be speeded, Finger said, there would be the problem of running several test reactors concurrently. Also, since a test releases some long-lived fission products, it is

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necessary to wait until the site cools before approaching it.

• **Materials problem**—Developing a high-temperature reactor, Finger declared, is largely a materials problem. "We are looking at the whole range of high-temperature materials, asking such questions as whether they are compatible with uranium compounds; will they corrode more readily under intense radiation; do they react with hydrogen at high temperature; and what are their structural and other physical properties, such as neutron cross-section, when combined with uranium?"

Another major materials problem, he said, is the effect of radiation on the properties of materials at cryogenic temperatures. Liquid hydrogen, the only propellant under consideration, boils at −423°F. NASA has contracted with the Georgia Division of Lockheed Aircraft Corp. for a major research project.

"It may be possible to protect materials, such as with shielding," Finger remarked. "However, if these material tests prove negative, we may conclude that the *Rover* rocket is simply not feasible."

AEC's Armstrong has this view of feasibility:

"To establish the feasibility of a nuclear rocket reactor, one must in effect build a prototype. All experiments prior to that are useful and necessary tools.

"Theoretically, you could prove the feasibility of any nuclear device without regard to the end requirements as it pertains to the engineering requirements such as light weight, compactness, etc. However, you might end up with something that couldn't be built. Naturally, we do not proceed in this manner. In demonstrating feasibility, we always keep the end objective and the engineering requirements in mind."

The AEC official declined to estimate how many experiments might be required to demonstrate the feasibility. "I have tried to avoid any such indication," he said.

The time between experiments is no sure indication of the pace of the program, Armstrong continued. "If we ran two experiments in one summer, it might not be as much of an increase in pace as if we stopped one line of experimentation and built new facilities to begin another—resulting in a long period in between."

At this week's hearing, the Atomic Energy Committee will try to determine how much increase in pace is possible. James T. Ramey, the committee's executive director, has asked Dr. T. Keith Glennan, NASA administrator, and Gen. A. R. Luedecke, AEC general manager, to comment on this outline of suggestions by the committee:

• Immediate establishment of performance specifications for the engine for flight test.

• A schedule calling for ground launching at the earliest possible date.

• Complete responsibility for development assigned to the AEC through the flight test phase—with the proviso that NASA will provide consultation and assistance.

"We want to be assured that, looking to the future, the *Rover* program is receiving the proper emphasis," Sen. Anderson declared.

Industry's Role in Nuclear Rocketry

Industry is playing a growing role in nuclear propulsion. Almost every major company involved in rockets, aircraft and electrical equipment is engaged in research and development aimed at the day not too far off when large-scale government contracts will be let.

So far, only a few large contracts have been awarded. The major share of the work is performed at government installations such as the Los Alamos Scientific Laboratory, operated for the Atomic Energy Commission by the University of California.

But as Project *Rover* and other propulsion projects shift from R&D to hardware construction, the share of the work performed by industry will increase.

Sen. Clinton P. Anderson, chairman of the Joint Congressional Committee on Atomic Energy, has proposed that an industrial contractor be brought in at "an early date" to work with Los Alamos on *Rover*. He did not specify the timing further, however.

Actually, there are three major areas of work on nuclear propulsion: manned aircraft, air-breathing missiles and rockets. Each area has distinctive problems. But many of the problems are similar. Any flying nuclear device must have a high-power reactor of extremely light weight. Any nuclear propulsion system faces the vexing problem of engineering the shielding of equipment and in some cases men from nuclear radiation.

Thus a company with R&D experience on any nuclear propulsion system has a good selling point when bids are asked on any other system.

How much money will be involved? No one in authority will make a public estimate of the eventual cost of a nuclear rocket. However, it is certainly safe to predict that the cost of R&D and construction for the nuclear propulsion unit in the first true space ship—including marrying the propulsion unit to the vessel—will be several billion dollars.

Despite the relatively low level of government funding, companies throughout industry are doing research at their own expense. Many companies are working on SR-149 and SR-151 contracts with Air Research & Development Command—under which cleared personnel of private companies are given access to classified data for work at company expense. In other companies, physicists and other scientists work purely with unclassified data.

In either case, the company's plan is to keep scientists at work on the problem in the hope they will come up with proposals that will interest the Air Force, the Atomic Energy Commission or the National Aeronautics and Space Administration.

• **Companies briefed**—NASA'S Harold B. Finger says all major companies were briefed on the outstanding problems in nuclear rocket propulsion. No effort was made to divide up the work, he said. Instead, the government agencies are relying on the competitive approach to produce best results.

The nuclear aircraft program, a joint Air Force-AEC effort, includes two major industry projects. The older of the two is the direct cycle system, under which air passing through a reactor is heated and expelled through a turbine and jet nozzle—providing thrust in somewhat the same fashion as a chemically powered turbojet engine. The General Electric Co. is carrying out the direct cycle program at Evendale, Ohio.

The other propulsion project is the indirect cycle system, under development by Pratt & Whitney Division of United Aircraft at CANEL (Connecticut Aircraft Nuclear Engine Laboratory) in Middletown, Conn. In this system, liquid metal is used to conduct the heat from the reactor through a radiator heat transfer system to the engine turbine and jet nozzle.

The indirect cycle system has a higher performance potential than the

direct cycle because liquid metal has greater heat-transfer capacity than the combination of air and other materials used in the direct cycle system. However, the direct cycle system is farther down the development road.

AEC Chairman John A. McCone has said that a decision will have to be made soon between these two competing systems.

Last March, the Air Force chose Convair Division of General Dynamics to work on initial design of a nuclear-powered aircraft.

Another air-breathing propulsion system is the nuclear ramjet, Project *Pluto,* in development under the supervision of the Lawrence Radiation Laboratory, an AEC installation operated by the University of California. The Marquardt Corp. is doing engine design and development for *Pluto* with Air Force funds. Atomics International Division of North American is doing materials research for the AEC.

Chance-Vought, North American and Convair have made studies for the Air Force of a *Pluto*-propelled missile named *SLAM* (Supersonic Low Altitude Missile).

A fourth major area where nuclear energy and propulsion meet is in some of the small SNAP (Systems for Nuclear Auxiliary Power) units under development for use in space. The SNAP devices break down in two major classifications. Small units with very low output, based on the heat from radioactive isotopes, are given odd numbers. Larger devices, based on nuclear reactors, have even numbers.

• **Heat from Polonium**—An example of the former is SNAP III, a device announced last April, which generated 2.5 watts from the heat given off by a small supply of Polonium 210. It still is in operation, although it has gone through several 138-day half-lives, currently generating about a half-watt. Such a small output would be of value only as auxiliary power, not for propulsion. Nuclear Division of the Martin Co. is developing the radioisotope units.

On the reactor side, under SNAP VIII, AEC and NASA are developing a reactor for a space vehicle that will generate 30 kilowatts of electrical power and weigh about 1500 lbs., exclusive of shielding. This is sufficient power to operate an electrical (ion or plasma) propulsion system that would develop a small but measurable thrust. Atomics International is developing the reactor-heated units for the AEC.

Early this year, ARDC requested bids on a 300-kilowatt SNAP-type nuclear reactor to power an ion propulsion device.

MISSILES AND ROCKETS asked the major companies for outlines of the

work they are performing related to nuclear propulsion. Most companies reported they are prevented by security from giving anything but sketchy details. Here are thumbnail sketches of what can be said:

• Rocketdyne Division, North American—Established special Nucleonics subdivision, employing about 45, to work in nuclear rocket engines, electric propulsion and advanced power conversion. Provided nozzles and propellant feed systems for Project *Rover* testing. Developed multistage axial flow turbopump for liquid hydrogen, which company says showed unusually high efficiency at pumping rates and discharge pressures not normally encountered in conventional rocket turbopumps. Working on nuclear rocket engine design at company expense.

• Bendix Aviation—Producing control systems for reactors used in nuclear ramjet and nuclear rocket engines (Projects *Pluto* and *Rover*). Delivered engineering research reactor to AEC for use by General Electric in development of aircraft nuclear propulsion project.

• Lockheed Aircraft Corp.—Georgia Division studying airframes for nuclear-powered aircraft. Research on effects of nuclear radiation on materials at cryogenic temperatures for NASA. Analytical studies of nuclear aircraft, rocket and advanced propulsion systems at Palo Alto Scientific Research Laboratory.

• Space Technology Laboratories —Evaluating performance capabilities of nuclear-propelled ICBM's, space vehicles designed for extreme payloads and those intended for extreme velocities. Research on advanced propulsion systems using nuclear energy, such as vortex or plasma core reactors, adiabatic compressors, plasma jets and combinations of these or similar methods. Applied research in related physical phenomena, such as diffusion phenomena, plasma behavior, reactor criticality and transfer of heat to a working fluid of low molecular weight.

• Reaction Motors Division, Thiokol Chemical—Carried out extensive studies in last three years on nuclear-propelled boost and space vehicles. Scientific personnel published numerous papers on heat-exchanger type nuclear rockets. Participating in Air Force studies; currently working on direct-conversion reactors, pebble-bed reactors, plasma systems, transient problems in control systems and nuclear space missions.

• Aerojet-General, Azusa Plant—Studied control systems and integration of reactor controls with propellant feed system on *Rover* in 1957 and 1958, while project was under AEC-Air Force jurisdiction. Has developed liquid hydrogen pump for hydrogen-oxygen chemical system that could be used in nuclear propulsion.

• Aerojet-General Nucleonics—Designed a special reactor called OPERA (Ordnance Pulsed Experimental Research Assembly) to produce pulses of as many as 10^{17} neutrons in a spectrum that peaks at 400,000 electron volts for studies of the effects of radiation on material.

• Grumman Aircraft — Studying heat transfer properties, reactor analysis, reactor shielding, radiation effects on materials and materials to make a missile more compact so as to investigate the application of a nuclear propulsion unit to a guided missile under a $1-a-year contract with the Bureau of Naval Weapons, allowing access to classified information.

• General Electric Co.—Employs more than 1500 in development work on direct cycle aircraft nuclear engine at Evendale, Ohio. Atomic Power Equipment Department, San Jose, Calif., has studied reactors from fractional kilowatt to a few megawatts as power supplies for electrical propulsion and auxiliary power. Designing reactors using both rotating and stationary converters, all at company expense. Officials feel large SNAP-type reactors should be developed more rapidly than at present, otherwise ion and plasma propulsion units will be available long before there are flyable reactors to power them.

• Pratt & Whitney—Important progress in the last year—although details remain classified—in such areas as test field elements, materials, liquid metal and critical assemblies for the indirect cycle aircraft engine. More emphasis to indirect cycle program is being given by the Air Force for Fiscal 1961.

• Westinghouse Electric—Astronuclear Laboratory established last August at Mt. Lebanon, near Pittsburgh, to study application of nuclear technology to outer space applications and advanced defense requirements. No actual government contracts signed in first six months but company says future looks promising. Laboratory making self-supported studies to analyze technical problems in programs under way to identify where it can help government efforts. Preparation of likely timetables for exotic propulsion systems.

• General Dynamics, Convair Division—Fort Worth plant selected to prepare preliminary design of nuclear aircraft. Krafft Ehricke studying numerous nuclear rocket and hybrid nuclear-chemical rocket designs. Company studied design of ramjet-propelled *SLAM*.

• General Dynamics, General Atomic Division—Studying feasibility of space vehicle propulsion through controlled nuclear pulses, for Advanced Research Projects Agency. Project to be transferred to Air Force.

• North American, Atomics International Division—Conducting basic materials research for Project *Pluto*, nuclear ramjet program. Produces SNAP reactors for AEC.

• North American, Los Angeles Division—Studied *SLAM* design.

• Martin Co., Denver Division—studying various applications of nuclear propulsion to space vehicles of the future; investigating fabrication of high-temperature reactor materials.

• Martin Co., Nuclear Division—producing isotope SNAP devices for AEC, developing air-transportable nuclear reactors, working with Navy on nuclear-propelled seaplane, producing nuclear components.

• Chance-Vought Aircraft—Studying *SLAM* with considerable outlay of company funds beyond those received under Air Force study contract.

• Douglas Aircraft Co.—Conducted detailed study of manned nuclear space systems; other classified work in progress.

• Tapco Group, Thompson Ramo Wooldridge—Spending about $1 million company funds annually developing power conversion systems devoted primarily to engines using liquid metal working fluids. Extensive component testing of mercury engines, including tests in zero gravity boiling, in a special Wright Air Development Center C-131B Flight Laboratory over Dayton. Corrosion research, condenser-radiator design, radiation heat transfer studies, experiments to determine meteor impact in radiator surfaces.

• Associated Nucleonics — Carried out conceptual and design studies of aircraft propulsion systems and facilities for developing systems as subcontractors to Oak Ridge National Laboratory, Martin, Pratt & Whitney and Curtiss Wright.

• Boeing Airplane—Studying powerplants, both propulsion and APU, comparing what companies active in field are doing. Keeping abreast of state of art. Not interested at present in building hardware.

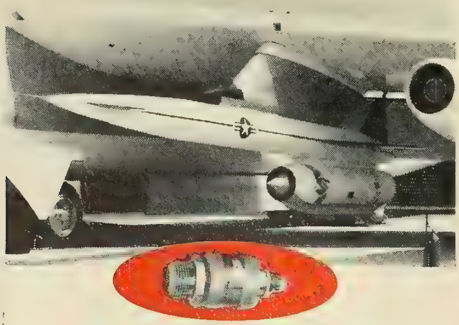
• Bell Aircraft—Classified nuclear research.

• Curtiss-Wright—Classified nuclear research.

• Douglas Aircraft Co.—Studies of high-thrust nuclear rocket systems.

• Sylvania-Corning Nuclear Corp. —Materials studies.

• Blaw-Knox Co.—Studies of facilities for testing indirect cycle aircraft reactor.



The Air Force's new Hound Dog missile is equipped with Aeroquip Quick-Disconnect Couplings. Both handling and checkout of the hydraulic systems are facilitated through the use of this coupling on the missile's internal system and ground service checkout equipment.

Space and weight are at a premium on the Quail. To save space, yet retain complete reliability, Aeroquip 1010 Series Quick-Disconnect Couplings are specified. These Self-Sealing Couplings are used in the fuel, lube oil and pneumatic systems of the compact Quail.

The Navy's new supersonic missile, the Corvus, is rocket powered. This swift air-to-ground weapon is equipped with a special Aeroquip Quick-Disconnect Coupling used as an umbilical disconnect. This coupling was especially designed for the Corvus by Aeroquip.

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RAMAC Computer Used for *Atlas* Spares

Transaction posting costs cut 12 to 20 cents: Convair expects to process 83,000 spare parts

SAN JOSE, CALIF.—For the first time, spares programing for an intercontinental ballistic missile has become a major task. During 1960, Convair-Astronautics expects to process more than 83,000 spare parts orders for the *Atlas* missile system. This is twice as many as last year and the program will continue to grow.

To handle inventory for the nation's first ICBM, the company is employing an International Business Machines RAMAC computer (Random Access Method of Accounting and Control). Its use was described here at a recent Aircraft and Missile Production Management seminar.

The seminar was one of a series initiated a year ago by IBM's data processing division. Report on the RAMAC in use at Convair-Astronautics was made by J. A. Dufresne, controller, and F. J. Knight, chief of data processing.

Magnitude of the spares program for *Atlas* was spelled out by Dufresne, who noted that test and operational sites stretch across the entire nation and may each require any number of the 100,000 different parts in the system.

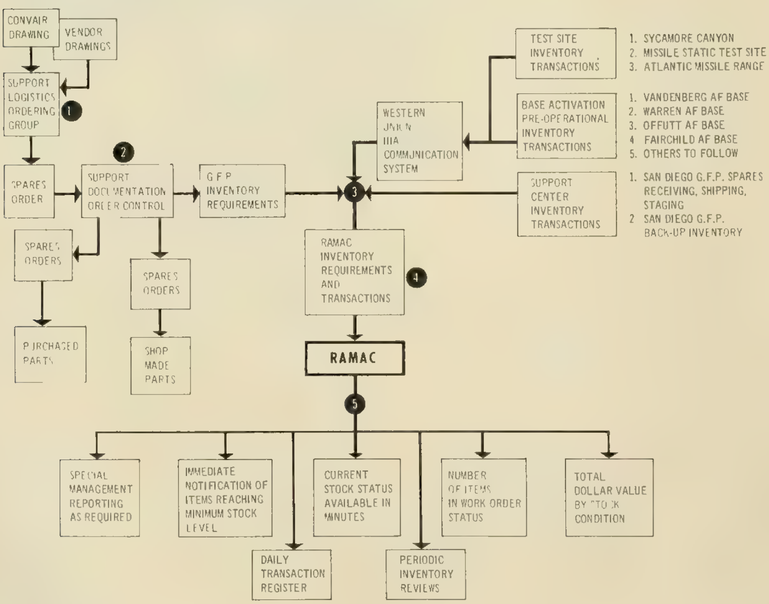
Although the missiles themselves need fewer spares than an aircraft since they fly only once, Dufresne pointed out, only a small part of the missile weapons system is airborne.

• **Spares for GSE**—"The majority of the system is involved in ground support equipment such as missile trailers, stands, launchers, test equipment, block houses and so forth, which is used launching after launching," he said.

In addition, rocket blast burns up certain umbilical connections and launcher parts at each launching. There also are a number of short-life items which must be replaced and, since development on the *Atlas* is continuing, some engineering changes still are being made.

"To manage a logistics task such as this," said Dufresne, "presents many complex and trying problems which can be solved only by efficient, rapid and reliable centralized control."

How RAMAC Is Utilized by Convair



Convair's portion of the spares program covers research and development, pre-operational base activation, initial operational capability, training, operation and management of Azusa, the tracking system used in launching.

(Spares to support the Strategic Air Command operational bases are controlled and managed by the Air Materiel Command through the electronic data processing center at Norton Air Force Base, San Bernardino, Calif.)

Knight said use of the RAMAC at Convair has cut cost per transaction posting from 20¢ to 12¢ each. He said it has speeded up interrogation time and also includes in the system the recording and control of in-transit material between inventory centers.

• **Requests pour in**—Knight said that as the *Atlas* program approached the operational stage "all hell broke loose" and requests for inventory statistics and management reports reached the point where it was economically unsound to produce them manually.

"In other words, our system of inventory control was dying on the vine," he said.

Convair's system at that point had evolved from what Knight called "the old faithful clerk and Kardex combination." A National Cash Register posting machine had been added and transactions were being posted at 16¢ a line.

As the program was stepped up, Astronautics installed a tabulating card file offset system which offered improved random access, a reduction in the costs of publishing inventory statistics and management reports, and the ability to expand with the increasing number of items.

But this upped the cost from 16¢ to 20¢ per posting and still left much to be desired. The order for the IBM RAMAC was placed in April, 1958.

Time required to program the system, Knight reported, was one year and 5000 man-hours. The task was carried out by two of Convair's top data processing men and one IBM programing consultant. In addition, a task group was formed to finalize the system and to establish the format of the reports that would be required.

The RAMAC initially ordered was a single density system with a 407 Tabulator on-line which rented for

$5200 a month. This has since been replaced by a double density system at $6200 a month, Knight said. The single density system has been retained, however, to maintain control of the 15,000 items in an overhaul and repair depot Astronautics is operating for the Air Force. It also will be used to handle future overflow, if any, from the double density system.

Input to the RAMAC locally in San Diego is through the keypunch section. Inventory transactions from offsite bases are received daily through a Western Union 111A, five-channel, punched paper tape system. As it is received in San Diego, the tape is converted to cards on an IBM Model 047 Tape-to-Card machine. These then are fed into RAMAC along with the San Diego information.

The RAMAC system, according to data chief Knight, replaced 14 clerks who were maintaining the offset tab card files.

• **Easily pleased Miss**—"The gross earnings of these girls," he told the seminar, "including the fringe benefits, equalled approximately $6300 per month and we don't have to worry whether or not Miss RAMAC will be grieved if we paint the wall green."

With a three-shift operation, Knight said, down-time on the system is averaging 20 hours a month, including preventive maintenance. The data processing crew required to maintain the operation consists of one data processing analyst, one and one-half operators per shift, and three and one-half keypunch and verifier operators, for a total of nine people.

Convair-Astronautics' RAMAC unit record consists of 400 characters per part number. Of these, the first 150 characters are set aside for constant indicative information about the part such as stock number, minimum stock level, lead time and failure rate.

The remaining 250 characters are used to maintain control of the inventories located at San Diego, the three test bases (Sycamore Canyon, Edwards Air Force Base and the Atlantic Missile Range), and the pre-operational spare parts at Vandenberg, Offutt, Fairchild and the other operational sites. Information includes allocated quantity, quantity received, quantity in transit, serviceable balance, reject balance, surplus awaiting disposition by the Air Force, and total stock on hand.

• **Spare Group**—Spares support is initiated with the flow of Convair and vendor drawings into the Logistics Support ordering group. This group selects from the drawings those parts which they recommend be ordered as spares. After approval by the Air Force, the authorized spare parts orders are for-

warded to the order control group.

In addition to ordering the required spares, this group generates the spare parts keypunch source documents which become the basic input to the RAMAC.

Output from RAMAC, as outlined by Knight, includes:

• Immediate notification of all parts at the minimum stock level.

• Full history of all parts removed from the serviceable inventory for repair or overhaul. This is used for follow-up to determine that these parts are returned to serviceable status as rapidly as possible.

• Dollar value of spare parts by the inventory condition of the parts, including costs of serviceable inventory, scrap and overhaul.

The RAMAC record also is used for special management reports and for processing of the periodic inventory reviews required by the Air Force.

"The report reflects the complete requirements and inventory position of those parts being reviewed," Knight pointed out.

The IBM machine can be interrogated at any time, he noted, even while it is performing other tasks. This makes it possible to obtain the complete up-to-date history of any part in printed form within 60 seconds.

Currently, such inquiries are averaging about 90 per day.

Sphere to Control Spacecraft Attitude

ANN ARBOR—By freely suspending a sphere in an electrical field, the Systems Division of Bendix Corporation says it has a key to a simple means for correcting and controlling the attitude of space vehicles. Company engineer Ralph Ormsby conceived of directing the rotation of such a sphere by signals from attitude-control sensors. The reaction to the rotation would then position a space vehicle.

The sphere is rotated by an electromagnetic torque introduced in proper measure into three mutually perpendicular windings connected to attitude sensors.

An example of the mechanism's use is in a satellite in which a particular window has to point to the sun. If the satellite moves out of this orientation, sensors pick up the information, send appropriate signals to the windings, which in turn spin the suspended sphere in the proper direction. The reaction to this rotation is transferred by magnetic linkage to the satellite which then begins correcting its error.

Bendix calls the mechanism a *Free Reaction Sphere*. Working models have performed successfully, one of which uses an 8-in. diameter, 20-pound sphere for the controlling mass.

Several advantages stem from this system. There are no bearing problems because the control mass (the sphere) is electrically, not mechanically, connected to the space vehicle. For the same reason, no gyroscopic moments are introduced. The most apparent advantage is that only one control element, a single sphere, is needed to take care of attitude corrections along all three Cartesian axes.

M-H Broadens Effort In Electronic Medicine

Minneapolis-Honeywell Regulator Co. has begun an extensive new program to expand activities in the field of electronic medicine. The company has assigned specialists to a newly formed medical instrumentation group to take over work already under way in three Honeywell divisions and institute new development programs in cooperation with medical authorities.

K. C. Rock, formerly chief engineer for Honeywell's Heiland Division, will head the new group. Headquarters will be at the Heiland plant in Denver, where much of the company's medical instrumentation work has been centered.

In addition to engineering responsibilities, the new group will take over marketing of all equipment Honeywell now supplies to the medical field, including body-function recorders, magnetic tape recorders, medical oscillographs, and other specially designed systems.

Electronic Circuits Formed By 'Gyro-Electric' Plasma

A practical electronic circuit has been formed by "gyro-electric plasma," according to a Sperry Gyroscope research physicist.

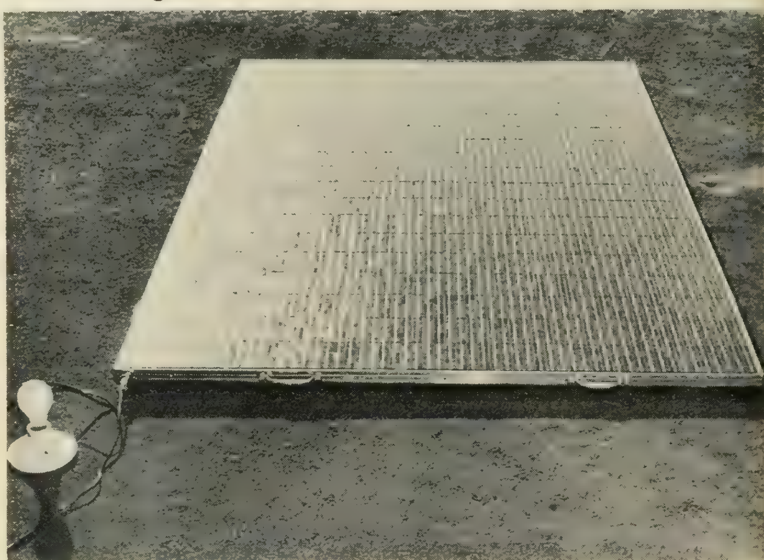
Speaking in New York before the Institute of Radio Engineers, Dr. James E. Hopson described the circuit as an electronic oscillator generating high-frequency radar energy. The research project has generated radar frequencies ranging from 700 to 2000 mc. Sperry scientists indicated that by redesigning their apparatus it will be possible with current technology to generate frequencies more than 100 times higher—a range approaching infrared.

The man-made plasma was formed by aiming a beam of electrons through rarified hydrogen gas contained in an electromagnetic envelope. The beam electrons strike the hydrogen atoms with sufficient force to knock them apart and create a plasma of charged pieces of hydrogen atoms and electrons.

The plasma behaves as an ordinary electric circuit which interacts with the electron beam and generates microwave radar energy. The plasma circuit couples into the electron beam which then serves as an antenna to convey the radar energy out of the plasma circuit for practical uses.

Plasma-formed electronic circuits may be used to replace devices that now use wires, capacitors, or conventional circuit elements.

World's Largest Solar Cell



"SOLAR KING"—the largest solar cell panel ever assembled, according to its creator, International Rectifier Corp.—can directly light a 100-watt electric bulb. It measures 26 square feet and contains more than 10,000 single silicon cells. IRC estimates that such panels can be made in mass-production quantities for $2000-3000. A similar unit, recently demonstrated, supplies energy to power the world's first sun-driven automobile.

Blue Streak Launch Platform Designed

by G. V. E. Thompson

LONDON—De Havilland Propellers Ltd. has released details of the launching platform they have designed for the *Blue Streak* LRBM. Several of these platforms are being constructed by Morfax Ltd., of Mitcham, Surrey, who has also carried out considerable development work since the building of the original prototype.

The completed platform weighs about 70 tons and is mainly fabricated from one inch steel plate. Each consists of two welded box beams (26x5x7 ft. high) with internal stiffeners of one and two inch plate. The two beams are connected by large pin-jointed cross braces of three inch plate. This assembly is carried by four bogies—one at the corner of each beam, set at an angle of 32½°—and rotates on a circular track. Each bogy is attached by a yoke bracket supported on a pivot pin and is capable of being jacked up and down on six inch diameter guide rods. This places the feet of the platform on the ground ready for firing the missile, or raises them when it is necessary to rotate the entire launcher.

The two box beams support the release for the rocket. It has four articulated arms, electro-hydraulically controlled.

Each bogy is fitted with two 20-in. diameter cast iron wheels driven through a straight-line gear box and chain drive. The total reduction is 357:1. The wheels rest on rails consisting of three inch square-sectioned bars welded on to a 1 in. by 9 in. section plate.

The prototype was built with mild steel, but later platforms have been made from Conlo 1, a notch ductile steel produced by Consett Iron Co. Ltd., Consett, County Durham. A typical analysis for Conlo 1 is 0.14% C, 1% Mn, 0.1% Si, 0.03% S, 0.02% P, and it is fully killed and grain refined (to ASTM grain size 6-8) by aluminum additions. This steel was used for the reactor vessels at Calder Hall nuclear power station. Most of the welding was done with Lynx manually-operated shielded metal-arc equipment, supplied by Quasi-Arc Ltd. of Bilston, Staffordshire (a member of the British Oxygen Company group). The shielding gas was Argonox (argon containing 2% oxygen).

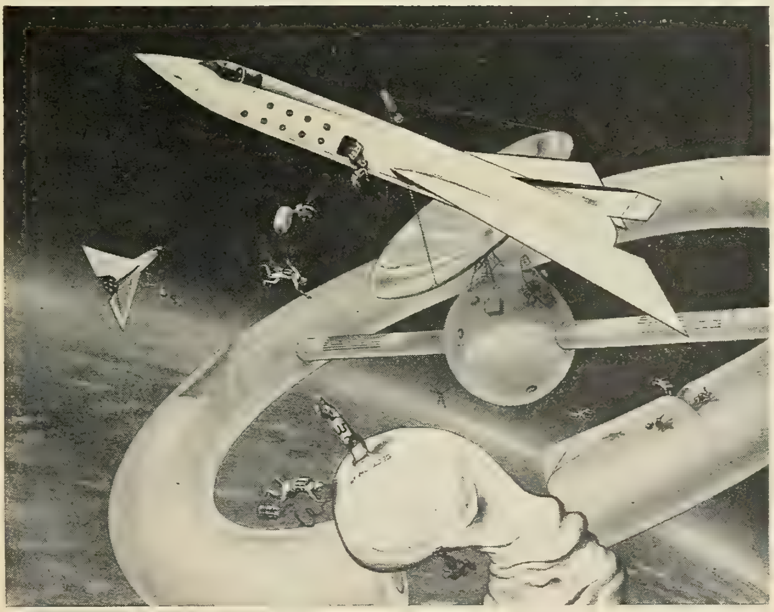
• **Welding process**—In welding the first platform, excessive distortion was observed, so subsequently each box beam was divided up into three subassemblies and the weld sizes were reduced. After the main welding operations were complete, but before the final assembly, the components were stress relieved. Heat treatment of the main box beams was carried out by G. A. Harvey & Co. (London) Ltd., of Woolwich Road, London, S.E.7., and consisted in holding at 650°C. for one hour per inch thickness and furnace cooling. Final machining and assembly followed.

Although the platform is massively constructed to enable it to withstand the shock loading and extreme temperatures to which it will be subjected, it also has to be produced to fine tolerance. The height of the trunnion bearings of the release gear arms above the level of the track has to be kept within ± 0.25 in. of 14 ft., while the centre distance between the trunnions also has to be accurately maintained. The maximum difference in level between any two points on the track itself is kept down to 0.006 in. by use of water-level micrometers.

Metalife liquid metal paint was used for protecting the surface of the structure. Tests have shown that this can withstand 12 hours' immersion in liquid oxygen. It also resists kerosene and prevents rusting under conditions of severe abrasion. Metalife Liquid Metals Ltd., Harrogate, Yorkshire also supplied the surface coatings for *Blue Streak* itself and other supporting equipment.

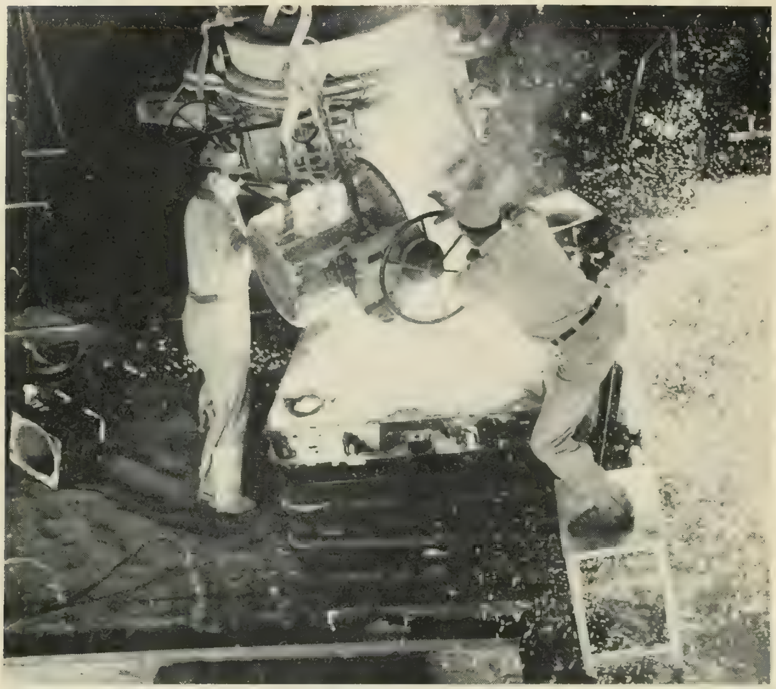
The bearing surfaces were considered to be too large for conventional plating and were therefore cadmium plated by the Dalic process, using equipment supplied by Metachemical Processes Ltd., 13 Strafford Road, London, W.3. In this process an absorbent pad attached to a tampon is soaked in the plating solution and serves as the anode.

Goodyear Concept



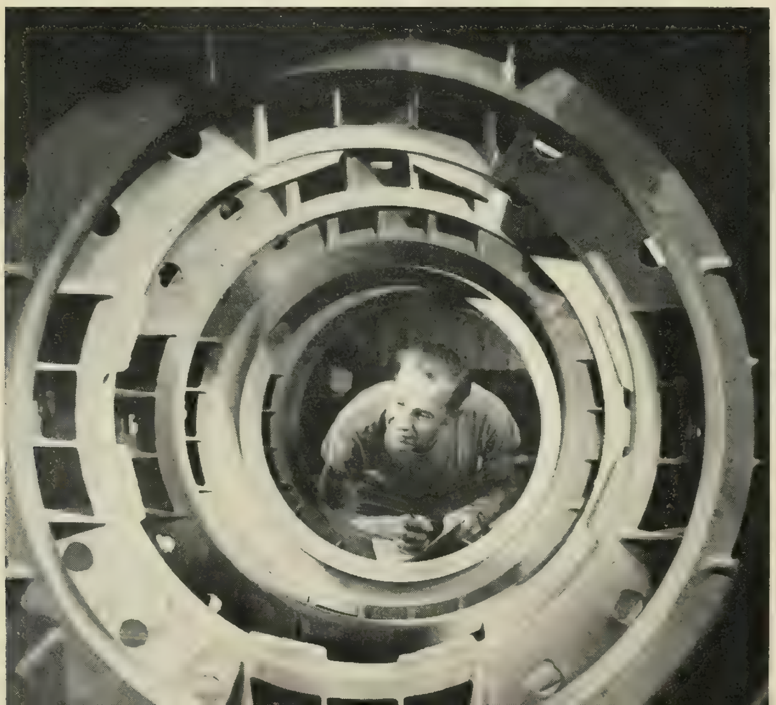
INFLATABLE SPACE STATIONS are envisioned by Goodyear Aircraft as a means of solving the problem of assembling metallic structures in orbit. Expandable coated fabric structures, according to GAC, could be packed in small containers for the trip into orbit, where they would be blown into shape like a balloon and "rigidized" by a quick-setting plastic foam. Large structures could be assembled from smaller "space cells." The technique also would provide a way to create a pressurized work area to put together space vehicles. Another application might be to use the cells for communications satellites, or for building structures on the moon's surface.

Steel Castings Have 280,000 psi



ACTUAL POURING of the cast takes only seven seconds. Temperatures are controlled to within a few degrees, insuring prompt filling and correct properties.

THESE COMPLEX structural steel castings have passed stringent inspections. Flaws permissible in normal castings would cause the rejection of these parts.



by John F. Judge

A process born in the fabrication of the business end of power shovels has developed into a promising source of complex, high-strength missile production parts.

It all started when metallurgists at American Brake Shoe Co. were faced with the problem of designing a special alloy tooth for a power shovel dipper. For certain applications, a very hard high-strength steel appeared to have distinct advantages. Research at American Brake Shoe to determine the best method of obtaining the needed properties led to development of a form of high-integrity steel casting.

Under Air Force sponsorship, high-integrity castings were studied and improved until many properties not available in conventional castings can now be produced by the proper selection of steel. Ultimate tensile strengths will range from 150,000 to 300,000 psi depending upon the nature of the working alloy. In some cases, tensile strengths of 260,000 psi can be guaranteed throughout the casting—with actual values running as high as 280,000 psi. When the criterion is extreme uniformity of properties rather than ultrahigh-strength, the tensile strengths will still range from 150,000 psi to 250,000 psi.

All of this is in marked contrast with conventional high-strength castings, which range around 150,000 psi —seldom reaching 200,000 psi.

• **Castings Inferior**—Castings have always been considered somewhat inferior to wrought steel products. This has been due to the higher strength of the wrought or worked steel—the mechanical properties being improved in the direction of the working.

On the positive side, castings have been attractive because of their ability to produce a variety of shapes almost to the finished configuration. In addition to the reduction of machining, parts of almost any size—from few to thousands of pounds—made in one piece, at relatively low cost and excluding the problems associated with fastening joints, have contributed to the success of castings.

The American Brake Shoe development eliminates the main drawbacks of this forming process and permits cast steel components to become competitive on a strength-weight basis for

the first time in the missile field.

High-integrity casting introduces more strength than previously possible, extremely high reliability, improved total uniformity and sacrifices only weight per unit part in achieving these qualities.

The actual process is a combination of proprietary materials and methods with extreme care and control. Such is the care involved in each step of the process that even a relatively minor mistake will degrade the final product to a point below the required levels.

The starting material is usually Swedish sponge iron or electrolytic iron. Conventional castings depend primarily upon scrap steel which costs but a fraction of the high integrity casting raw materials. The metallurgy in the new process is rigidly controlled —to within hundredths of a percent for the critical alloying ingredients.

The molds, historically the heart of the casting process, are made of proprietary mixtures which control the shrinkage rate in the cooling casting, impart good surface qualities and close dimensional tolerance and stability.

The mold for a complex missile part may take up to a week to prepare while the actual controlled pouring of the molten alloy lasts about seven seconds.

• **High Strength Induced**—The ultra-high strength properties are induced through a three stage heat treating cycle. In the homogenization cycle the casting is held at 1850°F for three hours then air cooled. The second step, austenitization, subjects the casting to two hours at 1575°F followed by oil quenching. The final tempering cycle brings the casting to 400°F for six hours followed by air cooling.

American Brake Shoe utilizes X-ray, isotope radiography, Magnagle, Zyglo and other methods in checking the properties of the final product. Defects ignored in conventional castings will fail a piece in this process.

In the entire high integrity method the actual yield per part is low. A 360 lb. missile casting may take 1200 lbs. of metal. The excess goes into gates and risers which are subsequently removed. The excess is re-usable since its metallurgy is known exactly and it can be added to the charge of the next casting.

The "as-cast" surfaces are usually good enough to require little or no machining. The reliability from part to part is almost perfect.

The question of cost is relative. Compared to conventional casting it is quite high but this is not the area in which high integrity casting is designed to function. Where the final product is a highly stressed part, where complexity, high strength and light

CORES ARE carefully set in specially prepared ceramic molds.

weight go hand in hand, high integrity castings are competitive with forged, machined, welded or milled products—and are usually less expensive.

The difficulty in cost comparison in the missile field is that the comparison must rest on products of extremely tight tolerances and limited application. The dollar value is often lost in the attainment of a specific objective.

High integrity casting is still in a transistory stage. Work is continuing to improve the process and to broaden its applications within the metallurgical limits of casting.

American Brake Shoe has supplied Grumman Aircraft, Douglas Aircraft and Chance-Vought with high integrity castings.

Space Vehicle Insulation Concept Gets AF Funding

Aerodynamic heating problems associated with re-entry and high speed atmospheric flight may be solved through Bell Aircraft's double-wall structural cooling concept.

The Air Force just granted a $1.4-million contract to the Buffalo, N.Y. firm for the development of manufacturing methods for the insulation concept.

Basically, the structure consists of an outer wall radiation shield and an inner wall, separated by a layer of thermal insulation. The outer wall is built with small expandable panels of heat resistant material which radiate some of the heat away from the vehicle surface. Tubes in the inner wall contain a circulating liquid which transfers absorbed heat to an expendable fluid such as water, and is later ejected as steam.

Company spokesmen say that leading edges will be made of some high heat sustaining material to provide additional protection.

Bell has been investigating this method for over six years and has successfully flight tested some experimental configurations.

The contract, awarded by the Aeronautical Systems Center of the Air Material Command, Wright Patterson Air Force Base, Ohio, calls for Bell to determine the best fabricating methods of double-walled structures and to further demonstrate the feasibility of the concept in solving re-entry problems.

Ball Bearing Tolerances Improved at MIT Labs

Ball-bearings with tolerances of 20 millionths of an inch are being mass produced by the Barden Corp., Danbury, Conn., using specifications and methods perfected at the Instrumentation Laboratory of the Massachusetts Institute of Technology.

The program, initiated five years ago because of the rapid advances in gyroscope design, resulted in the production of bearings machined so precisely that it is termed a "significant technical advance" by engineers at the laboratory.

The bearings are used in ultra-precise inertial guidance systems and their contribution is such that the accuracy of these systems exceeds expectations of only a few years ago.

Air gages and linear transformer transducers were improved considerably during the project as were shop machine tool techniques for increasing the percentage of highly accurate bearings.

The advance was the result of a concerted push by the Ballistic Missile and Wright Air Development Divisions of the Air Force without waiting for the market itself to grow sufficiently to make the work spontaneous. The entire project was a joint effort of Barden, MIT and the Air Force.

Reds Claim Extrusion of Microthin Lead Wires

The Russians have reported that they have successfully extruded lead wires in the 1-2 micron range from the molten metal.

V. Belov, engineer at the Electro-Physical Institute of Metallurgy of the Academy of Sciences, USSR, said that Soviet scientists have perfected a method of extruding aluminum and lead wires from the melt held under pressure in an inert atmosphere.

Plates rolled from the extruded aluminum wire have much greater structural strength than ordinary aluminimum plates because of the larger surface oxidation of the metal during extrusion.

Lead plates rolled from extruded wires increase the capacity of storage batteries because of the greater porosity of the material.

The Russian scientists used glass as the lubricant, and diamond dies.

The development was reported in the Soviet daily, *Sovetskaya Aviatsiya* (Dec. 24).

Missile Fluid Systems Cleaning Facility Opened

A certified cleaning facility capable of meeting the requirements demanded of missile fuel, hydraulic, liquid and LOX systems has been opened at Dunbar Kapple, Inc., Batavia, Ill.

Originally designed to remove particle contaminants in the firm's production of flexible metal hoses, the facility is now open to missile component manufacturers.

Components are subjected to several cleaning phases in a dustproof room. Personnel wear special clothing to further reduce the danger of contamination. After cleaning, the parts are dried, inspected and packaged before being admitted to the shipping area.

House Group Confers with Scientists

In article written exclusively for M/R, committee chairman tells of plans for nation's first panel on Science and Technology

by Rep. Overton Brooks (D-La.)
Chairman, House Committee on Science and Astronautics

This month for the first time in our nation's history, representatives of the scientific community will sit down around a conference table with Members of Congress and exchange views and recommendations on the scientific needs of the country.

On March 24 and 25, some 12 or 14 of America's outstanding scientists and engineers will come to Washington to meet with the House Committee on Science and Astronautics—the Committee which has been instrumental in gathering together this group of leading scientists to serve as a Panel on Science and Technology. Tentative plans call for two meetings a year.

Heretofore, there has been a lack of communication between the sciences and Congress, between the sciences and the general public, even between the various scientific fields themselves. The Committee believes the Panel will bridge this gap in communication, thereby keeping us constantly aware of new scientific advances that can be translated quickly into defense programs or into our own "spectaculars" in space exploration. We feel this capability is urgently needed as insurance against the aggressive ambitions of the Soviet Union.

• **Laws may follow**—The purpose, then, of the Panel is to increase the effectiveness of the Committee, both in the interest of Congress and of the scientific community at large as it represents national interests. Members of the Panel will present to the Committee their views and recommendations on scientific and space programs which they feel should be encouraged and initiated. The Committee will give these recommendations the utmost consideration and, if necessary, enact such legislation as is required to carry them out. It is planned later on to establish special task groups to undertake particular assignments as may be made by the Committee.

The Panel will, of course, greatly assist the Committee in keeping abreast of new scientific breakthroughs and developments.

Other ways in which the Panel will be called upon to help the Committee are:

• Advise as to current methods for conducting research;

• Provide information concerning the availability of scientific manpower and also on educational needs;

• Provide information concerning matters of international cooperation and organizations concerned with science, and

• Maintain channels of communication between Congress and the scientific community.

Members of the Panel have been selected on a strictly non-partisan basis—professional qualifications were the first consideration. Assistance in making the selections was given the Committee by the National Science Foundation, the National Aeronautics and Space Administration and the National Bureau of Standards. Scientific fields represented include biophysics, chemical engineering, applied mechanics, chemistry, meteorology, geology, medicine, aeronautical engineering, nuclear physics, astronomy, jet propulsion, genetics and zoology.

In subsequent meetings, written contributions from each Panel member will be invited and these papers, along with the recorded proceedings of each session, will be edited and printed for issue as public documents. It is expected that they will provide valuable contributions to scientific literature and serve to represent the informational function of Congress to general public and scientific community alike.

The Committee on Science and Astronautics is the first committee devoted to science in general in the Congress. Our interest in science and technology is motivated by the deep conviction that the greatest resource and strength of the American people and the nation lie in the ability to translate new ideas, new concepts, and new developments into reality through proper liaison, organization and the application of sufficient resources. Leadtime between concept and reality must continue to be shortened and every possible method to reduce the time lag must be explored. Important pools of scientific information and knowledge accumulating elsewhere in the world must be tapped and made available to the free world.

In response both to Soviet outer space achievements and to the Soviet propaganda exploitation of them, the world image of Soviet progress has been enhanced. There is no doubt that our friends abroad are watching our own future progress and achievements.

We on the Committee have no doubt that the new Panel on Science and Technology will help us greatly in our goal of keeping the United States foremost in scientific development. We have full confidence that through coordinated effort on a broad scientific front our country can and will demonstrate the leadership which is historically associated with free men.

Weighty Panel

Members of the first Panel on Science and Technology sponsored by the House Space Committee:

Dr. Lee A. Dubridge, *Physics, California Institute of Technology;* Dr. Thomas F. Malone, *Meteorology, Massachusetts Institute of Technology;* Dr. Edward J. Baldes, *Senior Consultant in Biophysics, Mayo Clinic;* Dr. Clifford C. Furnas, *Chemical engineering, Chancellor of the University of Buffalo;* Martin Goland, *Applied mechanics, Southwest Research Institute;* Prof. W. Albert Noyes, Jr., *General chemistry, University of Rochester;* Dr. Clarence P. Oliver, *Genetics and zoology, University of Texas;* Dr. Sverre Petterssen, *Meteorology, University of Chicago.*

Dr. Roger Revelle, *Geophysics and oceanography, Director, Scripps Institution of Oceanography, University of California;* Prof. Richard L. Russell, *Geology, Louisiana State University;* Dr. H. Guyford Stever, *Aeronautical engineering, Massachusetts Institute of Technology;* Prof. James A. Van Allen, *Nuclear physics, cosmic rays, State University of Iowa;* Dr. Fred L. Whipple, *Astronomy, Director, Astrophysical Observatory, Smithsonian Institution;* Prof. Maurice J. Zucrow, *Jet propulsion, Purdue University.*

CONGRESSMAN JOHN TABER (R-N.Y.), left, listens to Senator Leverett Saltonstall (R-Mass.), center, and Congressman Frank T. Bow (R-Ohio).

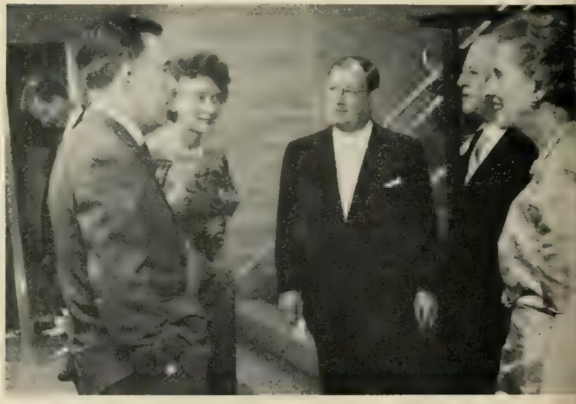
SENATOR WARREN G. MAGNUSON (D-Wash.) is greeted by Mr. Gross. Mr. Parrish is in background.

Lockheed Chairman Gross Honored i

MR. GROSS, left, chats with Senator Stuart Symington (D-Mo.).

A host of Washington celebrities attended a reception recently honoring Robert E. Gross, chairman of the Board of Lockheed Aircraft Corp., and Mrs. Gross at the home of Wayne W. Parrish, president and publisher of American Aviation Publications, Inc., publishers of MISSILES AND ROCKETS MAGAZINE.

Among the 175 industry and government leaders attending were many Senators and Representatives, some of whom are shown here. Mr. Gross was in the capital to appear also at the annual Silver Quill dinner of the National Business Publications. He spoke on behalf of the aircraft/missile/space industry.



SENATOR HENRY M. JACKSON (D-Wash.) chatting with Mr. and Mrs. Gross. In rear are Mr. and Mrs. Parrish.

SENATOR HERMAN E. TALMADGE (D-Ga.) and Mrs. Talmadge are greeted by Mr. and Mrs. Gross.

ELWOOD "PETE" QUESADA, FAA Administrator, and Mrs. Quesada (left) talk with Mr. Gross.

Vashington

SENATOR KARL MUNDT (R-S.D.) and Mrs. Mundt are introduced to Mr. and Mrs. Gross by Mr. Parrish.

MR. J. W. CROSBY, president of Thiokol Chemical Corp., talks with Mrs. Gross. At rear left is Congresswoman Katharine St. George (R-N.Y.).

LT. GEN. JAMES H. DOOLITTLE, USAF (Ret.), Chairman of the Board of Space Technology Laboratories, Inc., center, talks with William C. Foster, Director of Olin Mathieson Chemical Corp., and Mrs. Foster.

SECRETARY of the Air Force Dudley C. Sharp chats with Mr. Gross.

TESTING, INC. BOUGHT: Testing, Inc. Los Angeles, has been acquired by Idaho Maryland Mines Corp., Glendale, and reorganized as Universal Research and Testing Laboratories. Company will continue qualification, evaluation, research and reliability testing for electronic, electro-mechanical, pneumatic and hydraulic components and systems for aircraft and missiles. A new research department has been created to conduct studies and simulate space environment.

AVIEN BUYS: Colvin Laboratories, which recently merged with Pressure Elements, Inc., has in turn been acquired by Avien, Inc.

NAME CHANGE: CGS Laboratories, Inc. is in the process of changing its name to Trak Electronics Co., and for the present will operate under the name Trak Electronics Co., a division of CGS Laboratories.

NEW FACILITY: General Electric Co. is now in occupancy of its Special Programs Section facility in Radnor, Pa. It will concentrate on GE design and development capabilities on the system requirements of the Army.

$500,000 EXPANSION: Sylvania Electric Products, Inc. will spend $500,000 in the expansion of facilities for the production and processing of a single crystal germanium and silicon for use by the semiconductor industry. The Chemical and Metallurgical Division's program will be housed in existing buildings at Towanda, Pa., and operating within 90 days.

ANOTHER DIVISION: Bethlehem Foundry and Machine Co. organizes a new Environmental Engineering Division to specialize in electronics and missile field products.

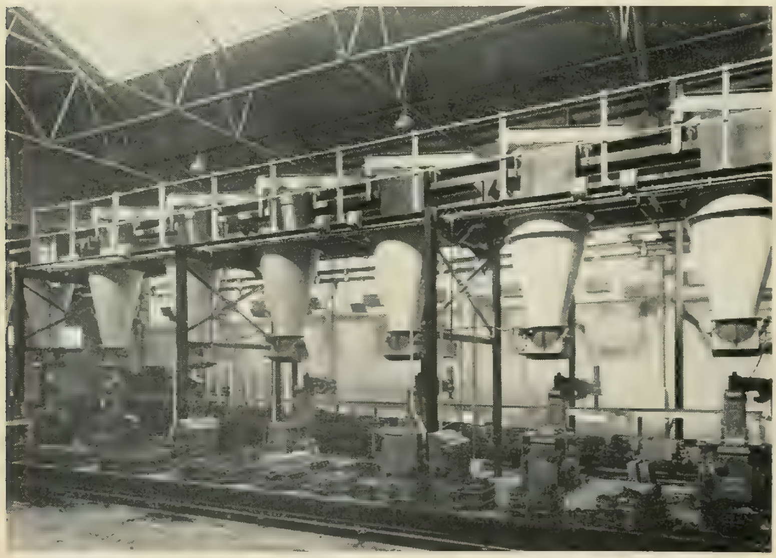
PLANT DEDICATION: Air Reduction Sales Co. Division of Air Reduction Co., Inc., dedicates the companies newest liquid air separation plant at Fairfield, Alabama. The multimillion dollar facility will produce liquid oxygen, nitrogen and argon.

AEC EXPANSION: The Atomic Energy Commission has let a contract for the construction of a new Metals and Ceramics Facility for the Metallurgy Division at the Oak Ridge National Laboratory. The entire project will cost $6,500,000.

3M GROWS: Minnesota Mining and Manufacturing Co. plans to double the size of its branch office and warehouse in Buffalo, N.Y.

CENTER OPENS: Food Machinery and Chemical Corp. Chemical Research & Development Center at Princeton, N.J. has been completed on schedule.

Foundry Plant Expands



GORHAM ELECTRONICS, Division of Gorham Mfg Co. is modernizing its microwave foundry facilities, in response to rising demands for microwave equipment.

financial news

Texas Instruments more than doubled its sales and profits in 1959.

The company financial report for the year just ended shows sales of $193.2 million and net income of $14.1 million. This compares with 1958 sales of $91.9 million and net income of $6 million. T-I's backlog on Dec. 31 was $101.1 million, including $47 million in government business.

Other financial news:

• **North American**—A 50-cent dividend on common stock has been declared, bringing to $1 dividends declared since Oct. 1. The company predicts FY 1960 sales will top $1 billion.

• **Ryan Aeronautical**—Sales rose in the first quarter of 1960, but profits slipped. The company's quarterly report lists sales of $20 million and net profits of $247,633 compared to sales of $16.9 million and profits of $560,527 for the same period last year.

• **Thompson Ramo Wooldridge**—Record 1959 sales of $417 million and net income of $9.7 million are reported. Sales in 1958 were $340 million and earnings $8.9 million.

• **Westinghouse Electric Corp.**—Officials said 18% of its 1959 sales of $1.9 billion were in the defense and nuclear propulsion field, about the same as the previous year.

• **General Controls**—Sales in 1959 hit a record $40 million. Profits were $1.6 million. This compares to 1958 sales of $33.7 million and net income of $1.4 million.

• **Textron Electronics**—In the first seven months after its organization in the middle of last year, it had sales of $9.8 million and profits of $384,000.

• **Perkin-Elmer**—Increased second quarter sales and earnings for the quarter which ended Jan. 31 reported. Sales for the quarter were up 39% and profits up 61% over 1958. Sales for the six month period were $8.6 million and earnings $342,919—slightly ahead of the same period in the previous year.

—letters—

Armour's Independence

To the Editor:

Your February 22 issue contained an item on page 32 about an Armour Research Foundation project for which we are deeply grateful.

The article, however, mentioned that Armour Research Foundation was part of the University of Illinois. The U. of I. has cast longing glances at Illinois Tech's campus in its efforts to obtain a Chicago campus, but so far we have resisted state legislators and governor's committees and still remain a private technological institution.

This is not a complaint, only a correction of a situation caused, no doubt, by the confusion of names. It happens every so often.

Daniel G. Cahill
Manager of Public Relations
Armour Research Foundation of Illinois Institute of Technology
Chicago 16, Illinois

'Floating' *Saturn*

To the Editor:

I was interested and intrigued by the statement in the March 7 M/R that "NASA, incidentally, has run calculations to determine whether *Saturn* would float if it were filled with hydrogen."

Permit one whose art is optics to express that all maneuverable lighter-than-air vehicles do not suddenly shoot skyward like balloons when deprived of their sandbags. All maneuverable lighter-than-air machines such as blimps and dirigibles contain *just enough* hydrogen or helium to permit their *effective density* to equal that of the surrounding air, and thus the energy required for maneuvering them is minimal. Further, the gas bags of blimps and dirigibles have hundreds of thousands of cubic feet of capacity, and their supporting structures may be equal in weight, or just a little heavier, than the gas bags. But for you to state that NASA ran some calculations to see whether or not *Saturn* would float . . . with its hundreds of tons of mass, and small tank capacity . . . tsk, tsk.

Frank M. Cameron
222 Holmes Avenue, N.W.
Huntsville, Alabama.

You're so right. But NASA made the calculations, not M/R. We merely reported that the results of the calculations show that it will not float—Ed.

Congress Slights Kaman

To the Editor:

Your issue of January 25 carried an article on Hébert Legislation and a compilation of defense companies. It listed Kaman as having 1270 employees. At the end of January 1960 we had 3050. Your information is badly out of date.

Weston B. Haskell, Jr.
Assistant to the President
The Kaman Aircraft Corp.
Bloomfield, Connecticut

Information listed was compiled by Congress, not M/R.—Ed.

—reviews—

TUNGSTEN, A BIBLIOGRAPHY, Sylvania Electric Products Inc., Chemical and Metallurgical Division, Towanda, Pa. 39 pp. $1.00.

A compilation of domestic and foreign tungsten literature references, this book is the first such effort in nearly six years to present in one volume all of the important advances made in tungsten technology. The most complete table of the properties of this element ever published is included together with 19 binary and ternary tungsten phase diagrams, many of which were developed only during the last few years.

CRYOGENIC DATA BOOK, D. B. Chelton and D. B. Mann, National Bureau of Standards Cryogenic Engineering Laboratory for WADC. Order PB 151837 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 155 pp. $3.

The physics of eight liquefied gases and over 140 solids at the same extreme temperatures are illustrated. More than 100 full-page graphs present curves for such factors as densities, vapor pressures, heats of evaporation and conversion, specific heats, surface tension, thermal conductivity, and percent of liquefaction for helium, para and orthohydrogen, and others.

Additional graphs delineate the properties at liquid gas temperatures of selected metals, glass and insulating plastics. The appendix includes handy tables of boiling points, characteristics of stainless steel, fluid properties, water vapor absorption and similar aids.

FREE-FLIGHT INVESTIGATION AT MACH NUMBERS BETWEEN 0.5 AND 1.7 OF THE ZERO-LIFT ROLLING EFFECTIVENESS AND DRAG OF VARIOUS SURFACE, SPOILER, AND JET CONTROLS ON AN 80° DELTA WING MISSILE. Eugene D. Schult. Order NASA Technical Note D-205 from OTS, U.S., Dept. of Commerce, Washington 25, D.C. $1.25.

Tests were made of various deflected surfaces, spoilers, and inlet-air-jet devices to substantiate simple theory for deflected surfaces, and to determine some effects of chordwise location for spoilers and blowing direction and spanwise location jets.

The fuselage shape was modified for one case. The results demonstrated that all controls were satisfactory roll-producing devices except the canards immediately forward of the main wings and the spoilers at other than training-edge locations.

WRAPPING GLASS tape on solid propellant charge for Rocketdyne generator.

Generators Built for *Tartar/Terrier*

Rocketdyne Division, North American Aviation, has developed two compact solid-propellant gas generators to provide electric power and drive the hydraulic system on the Navy's *Tartar* and *Terrier* surface-to-air missiles.

Both units were developed and are produced at Rocketdyne's Solid Propulsion Operations in McGregor, Tex. The MK2 generator serves the electrical systems. The MK3 develops power for the hydraulic turbines.

Each generator has a boost disc of fast-burning propellant cemented to the starting end of the main propellant charge. The disc provides the instantaneous burst of power needed for starting the machinery.

Both use a clean-burning extruded grain with ammonium nitrate oxidizer. Rocketdyne says the propellant leaves no detrimental deposit on turbine blades and units can be stored for long periods without special care.

The fast-burning boost disc uses a combination nitrate-perchlorate oxidizer. Control of the necessarily high boost pressure, which levels off within 0.8 second of firing, is achieved in the design of the propellant charge. After the boost disc burns, the main stage of the propellant consists of a relatively cool-burning adaptation of the ammonium nitrate propellant used in the M15A1 JATO.

The MK2 boosts the electric systems to rated output in about 0.5 second. The MK3 lifts the turbines to rated speed within 1 second.

Cases for the generators are made of 4130 steel. The charge is covered with an inhibitor and then wrapped with glass tape. Additional protection for the case wall is provided by a sleeve of insulation. In the head of each unit, a molded insulator is used.

The *Tartar* and *Terrier* are manufactured for the Navy by Convair/Pomona, Convair Division, General Dynamics Corp.

Circle No. 225 on Subscriber Service Card.

Environmental Test Cabinet

A new environmental test cabinet with special "add-on" facilities for altitude, vacuum, humidity and temperature testing answers the needs of laboratories with expanding environmental test requirements. The unit is available from the Hudson Bay Co.

Called the Com-pac Cab, it is designed specifically for low temperature operation with an adjustable temperature range from 300°F to —120°F. Varied testing can be had by merely adding optional equipment. The working chamber is 19" x 19" x 19".

Circle No. 226 on Subscriber Service Card.

Honeycomb Core Materials

Hexcel Products Inc. has developed a series of new fiberglass heat-resistance honeycomb core materials for use in missiles.

The material, described as the "strongest and lightest plastic honeycomb ever produced," is the result of two years of research work carried out at Hexcel.

Trade-named HRP, the heat-resistant phenolic core consists of woven glass cloth impregnated with a high-temperature phenolic resin and separately applied high-temperature phenolic dip coats.

The entire HRP series includes six different core materials ranging in density from two pounds per cubic foot to 15 pounds per cubic foot in cell sizes of 3/8 in. and 3/16 in. permitting Hexcel to meet an extremely broad range of high-performance requirements.

The lower densities are designed for use in highly loaded aircraft and missile components, the middle densities for primary aircraft structures, and the higher densities for marine structures such as hydrofoils and underwater containers.

In addition to having a high strength-to-weight ratio, the HRP cores also have a higher resistance to moisture than any other type of honeycomb—including stainless steel and aluminum. The latter eventually suffer corrosive attack when continuously exposed to a salt spray environment. Under the same conditions, HRP cores remain intact.

Circle No. 227 on Subscriber Service Card.

High Frequency Transistors

Pacific Semiconductors, Inc. announces the industry's first Very High Frequency Silicon Mesa Power transistors capable of delivering one watt power output at 70 mc. with a 28 volt collector voltage.

The two new types, designated as 2N1505 and 2N1506, are characterized by 3 watt collector dissipation, 40v collector-to-emitter rating, and low collector capacitance. The units are particularly well suited for VHF power application in communications and telemetry equipment where severe en-

vironmental conditions are encountered.

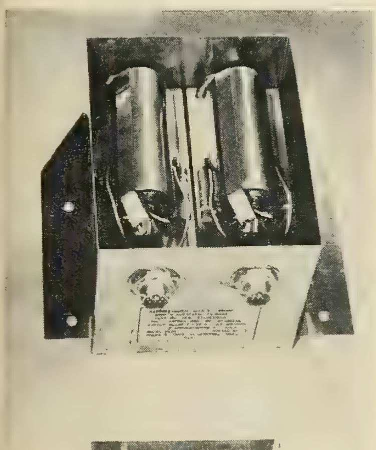
Type 2N1505 operates as an oscillator at 70 mc. with a power output in excess of 1 watt at an efficiency of 45%.

Type 2N1506 has a typical power gain of 12 db at 70 mc. with a useful power output of 1.0 watts. At 200mc the 2N1506 has a power output of 300 milliwatts.

Circle No. 228 on Subscriber Service Card.

Silver-Zinc Battery

A dual battery in a single case provides complete auxiliary power for missiles and space vehicles. The two battery sections in the Model P42A have identical output and capacity. They are intended for applications



where standby capacity is required, or where one circuit must meet a heavy peak current demand, while the other would have a steady, nonfluctuating load. The special pile-type construction has a voltage change of only 10% under maximum surge loads several times normal.

Each 19-cell section provides a current of 3 amperes at 26.5 volts. Maximum current is 15 amperes, with a discharge time of 40 minutes at 3 amperes. Capacity is 2 ampere-hours.

Both sections are activated automatically. The reliable activating mechanism is a simple electrolyte tank and piston arrangement, operated by a solid-propellant gas generator. Activation time is only 0.5 second. The signal required is 4 amperes at 28 volts.

Circle No. 229 on Subscriber Service Card.

Quenched Arc Cutting

A new line of three ELECTRO Band Machines, utilizing a new electrical machining process known as "quenched arc cutting," has been introduced by the DoAll Company. These machines are especially suited for machining honeycomb of aluminum, stainless steel or titanium, and other fragile cellular structures made of foil or thin-wall tubing.

As the name implies, ELECTRO Band Machining is an extension of the band sawing technique. It uses modified standard DoAll band machines and offers the band machining advantages of high-speed cutting and low material waste.

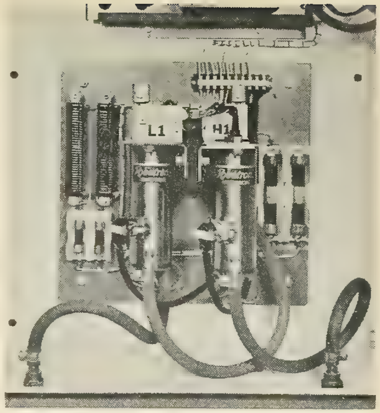
Work is sliced away by a band that removes as waste only 1/32 in. of material. Instead of making honeycomb core in rough individual blanks and grinding away waste material, it now is possible with ELECTRO Band Machining to start with a "log" and slice off pieces to finished size at substantial savings in both time and material.

Circle No. 230 on Subscriber Service Card.

Weld Control System

A new welding control and power system that combines all the advantages of normal resistance, capacitor discharge and percussion welding with none of their inherent disadvantages has been made available to industry by Robotron Corp.

Referred to as "spike power" welding, the development is a result of five



years' research by Robotron engineers. The system revolves around a new type of tube called a coaxial ignitron tube contactor which is capable of handling very high peak currents for short time periods without misfiring or breaking down, it is reported.

Resistance welding jobs formerly demanding very large welding transformers can now be done with the new control principle using transformers of only a fraction the size ordinarily required, the firm has discovered.

Because minimum heat is generated

between pulses, welding electrodes remain virtually cold. Temperature of the work pieces is confined to the interface contact area of the two metals. With little latent heat left in the parts, they can usually be handled with bare hands immediately after welding.

Circle No. 231 on Subscriber Service Card.

Portable Calibration Head

A portable, lightweight, calibration kit, designed to perform with laboratory precision and a high degree of dependability in field use, has been announced by the Electronics and Instrumentation Division of Baldwin-Lima-Hamilton.

This B-L-H SR-4 Calibration Kit provides a convenient versatile unit for checking and calibrating tension and/or compression loads output in weighing systems, jet engine test stands, missile thrust stands and similar applications. The kit contains a precision calibration indicator featuring digital readout and a high accuracy calibration load cell. Combined, these units are guarantee direct-reading accuracies of as high as 1/20% of reading.

One unique functional advantage of this kit is the ease of changing the broad range of operating capacities possible. Using available standard cells, these capacities range from 60 to 120,000 lbs. for tension service and from 60-240,000 lbs. for compression service. This is made possible by B-L-H's use of a special calibration model of its well-known SR-4 Load Cell as the load sensing element of this kit. It acts as a load transducer converting load changes into electrical values. A complete range of standard cells or cells specific applications may be supplied with this kit.

Circle No. 232 on Subscriber Service Card.

New Literature

BROCHURE. Dedar Engineering, a division of Control Data Corp., has released a brochure describing its line of miniature electrical and electromechanical devices. Described and illustrated are the company's miniature rotary devices, linear acceleration devices, control amplifiers, and complete servo and time function assemblies. Also described are supporting activities such as gyro modification and repairs, custom winding services, and environment/qualification testing laboratory services.

Circle No. 200 on Subscriber Service Card.

THERMOSTAT METAL. How thermostat metal elements can be stacked to satisfy performance specification in space that prohibits the use of a single element with sufficient material volume is the subject of a new 2-page data bulletin, TRU-11 by Texas Instruments Inc. Multiple element assemblies in series, in parallel, and in parallel-series are discussed. Rules for determining the thermal deflection, mechanical deflection, and force of each type of assembly, as compared to the properties of the single elements that make up the assembly are given.

Circle No. 201 on Subscriber Service Card.

EPOXY RESINS. Three new and different epoxy resins—displaying novel structure, reactivity and curing characteristics—are described in a 24-page booklet just published by Food Machinery and Chemical Corporation. The booklet deals with physical properties of the OXIRON 2000 series and tells how these resins differ from conventional epoxies of commerce. Cure systems are thoroughly described by means of actual formulas used to obtain a variety of end properties. Thirteen different tables present the physical and mechanical properties of the cured and uncured resins while 10 graphs illustrate such properties as high heat distortion points, exotherm and molecular structures.

Circle No. 202 on Subscribed Service Card.

STEPPER MOTORS. Technical brochure SP9-1, a 12-page booklet describing a new line of stepper motors and pulsed stepping devices, is available from The A. W. Haydon Company. For each of the new units in Haydon's stepping line—series 18100 motors, rotary stepping switches, pulse dividers, precision sequences, counters, interval timers and positioning devices —complete information is given. This includes product features, application and construction details.

Circle No. 203 on Subscriber Service Card.

HIGH PRESSURE SYSTEMS. A catalog from the Airdox Cardox Products Co., provides performance and engineering data on central compression systems for supplying air, nitrogen or helium at pressures to 12,000 psi and 170 scfm., with less than 4 ppm oil content and any degree of purification necessary.

Circle No. 204 on Subscriber Service Card.

THEODOLITES. A new brochure describing a series of azimuth alignment theodolites used to obtain azimuth accuracy of inertially guided ballistic missiles, has been published by the Electro-Optical Division of the Perkin-Elmer Corporation.

Circle No. 205 on Subscriber Service Card.

contracts

AIR FORCE

$273,000,000—Lockheed Aircraft Corp., Burbank, Calif., for satellite projects ($157 million for *Samos*; $60 million for *Midas*; $56 million for *Discoverer*).

$8,476,659—Hughes Aircraft Co., Culver City, Calif., for GAR-11 *Falcon* missiles, shipping and storage containers, spare parts, data and ground support equipment.

$600,000—Transval Electronics Corp., El Segundo, Calif., for two types of power supplies for activation of *Bomarc* ground support equipment.

$295,800—General Electric Co., Owensboro, Ky., for electron tubes.

$206,135—Radio Corporation of America, Defense Electronic Products, Camden, N.J., for switches, relays and contact assemblies.

$183,700—Hydromatics, Inc., Livingston, N.J., for flo-ball valves to be used in connection with the propellant loading system for *Atlas* silo launch complexes.

$99,300—Milgo Electronic Corp., Miami, Fla., for eight 17-digit timing code generators and auxiliary support items.

$77,182—Sylvania Electric Products, Inc., New York City, for electron tubes.

$74,995—CBS Electronics, Danvers, Mass., for electron tubes.

$52,457—Northrop Corp., Norair Div., Hawthorne, Calif., for rocket catapult test program for T-38 aircraft.

$46,901—Ronson Hydraulic Units, Charlotte, N.C., for spare parts for rocket assemblies used on F84 aircraft.

$45,000—Armour Research Foundation of Illinois Institute of Technology, for research concerned with the formation and growth of defect clusters in solids.

$43,570—Underwood Corp., Canoga Div., Fort Walton Beach, Fla., for central timing system for *Pershing* tracking.

$35,766—Republic Aviation Corp., Farmingdale, N.Y., for spare parts for rocket assemblies used on F84 aircraft.

ARMY

Giannini Controls Corp., Pasadena, Calif., for 12 "photopot" units, a semiconductor device which can be used as a potentiometer in guidance systems of advanced space vehicles. Amount not disclosed.

$12,555,160—Paul Hardemann, Inc., Stanton, Calif., for propellant loading system prefabs and interconnecting piping for ballistic missile operational and test facilities (7 contracts).

$5,333,673—Sperry Rand Corp., Salt Lake City, for research and development on the *Sergeant*.

$3,230,166—Sperry Rand Corp., for engineering services for *Sergeant* system.

$1,574,624—Thiokol Chemical Corp., for the production of *Falcon* rocket motors.

$720,000—Union Carbide Development Co., New York City, for research in physical and chemical principles affecting high-temperature materials in rocket nozzles.

$596,683—Joy Manufacturing Co., Dallas, for air washer and dust collector units for ballistic missile projects (6 contracts).

$230,761—Dean Hill Corp., Indianapolis, for centrifugal and turbine pumps for ballistic missile projects, various locations (6 contracts).

$227,168—Trane Co., LaCrosse, Wis., for air conditioning fan coil units for missile projects (6 contracts).

$223,277—Arvol D. Hays, Lubbock, Tex., for guided missile field maintenance shop, Walker AFB.

$191,700—Water Cooling Equipment Co., St. Louis, for cooling towers for ballistic missile projects (6 contracts).

$150,000—Columbia University, New York City, for program of research entitled "A Study of Target & ECM Simulator Problems."

$139,800—Key, Inc., Winchester, Tenn., for construction of addition to propulsion wind tunnel office building, Arnold AFB.

$134,773—Kearfott Div. of General Precision, Inc., Clifton, N.J., for design and fabrication of prototype integral rotary serve assemblies.

$69,257—Butler & Cobbs, Montgomery, Ala., for improvements to systems support equipment laboratory propellant and test area.

$60,264—Oak Mfg. Co., Chicago, for vibrator interrupter.

$49,732—Ampex Data Products Co., Atlanta, for FR-600 magnetic tape recorder/reproducer system with accessories.

$28,800—Astrobell, Inc., Canoga Park, Calif., for *Nike-Ajax* parts.

NAVY

$2,453,608—Motorola, Inc., Chicago, for 484 all-transistorized 10 inch radar repeaters.

$250,000—Precision Instrument Co., San Carlos, Calif., for instrumentation tape recorders and accessories. Subcontract from **Western Electric.**

$58,000—Avien, Inc., Woodside, N.Y., for temperature and shock monitor control systems for use on the *Polaris* missile.

NASA

$80,000—Fred S. Gichner Iron Works, Inc., for outfitting six trailer vans to be used in Project *Mercury*.

MISCELLANEOUS

Southwestern Industrial Electronics Co., Div. of Dresser Industries, Inc., Houston, for designing and building a "prototype" power amplifier for a new type rate-of-climb meter for missiles and aircraft. Subcontract from **Summers Gyroscope Co.**

$75,000—Datran Div., Automation Industries, Inc., Manhattan Beach, Calif., for digital strain indicators. Subcontract from **Budd Instrument Div., Budd Corp.**

BIDS

Air Defense System Branch (low altitude) Industrial Div., Army Rocket and Guided Missile Agency, U.S. Army Ordnance Missile Command, Redstone Arsenal, Ala.-Pallet loading and storage guided missile *XM-1*—175 each—RFP-DA-01-021-ARGMA-1HPE-60-2Q—Drawings and RFP are available from nearest Ord. Dist. Final submission date will be established by each Ord. Dist.

Fort Worth Dist., Corps of Engineers, U.S. Army, Ft. Worth, Tex.-Guided missile field maintenance shop, approx. 12476 S.F. combination unit masonry and metal siding building. Site preparation, utilities, 475 tons asphalt pavement, 553 of curb and gutter, 1046 1F 7 ft. chain link fence and two cathodic protection units. Dyess AFB area, Tex. Bid sets avail. at purchase price $5 per set for half-size dwgs. Full size dwgs avail. at $0.50 per sheet to holders of half-size sets—Job—IFB ENG-41-433-60-24B—Bid opening 30 Mar. 1960.

Purchasing and Contracting Div., White Sands Missile Range, N.M. Oscillograph, magnetic, 36 channels, range 0-4, 800 CPS, direct writer. Bid sets avail. through 28 Mar. 1960—1 each—IFB ORD-20-040-60-187—Bid opening 5 Apr. 1960.

National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif. Rotating mirror cameras, 2000 RPS, 3 ea.—Kerr cell shutter—1 ea. IFB A-2218—Bid opening 28 Mar. 1960.

names in the news

Harry A. Sandberg: Joins Rosemount Engineering Co. as head of manufacturing. Previously headed the fabrication engineering department at the Liquid Rocket plant of Aerojet-General Corp., after holding manufacturing supervisory positions at Librascope, Inc., Roylyn, Inc., and Bendix Aviation Corp.

SANDBERG

Robert F. O'Neill: Former quality control manager promoted to manager-manufacturing for Standard Steel Corp.'s Cambridge Division. **Thomas F. Duff, Jr.,** former chief inspector, succeeds O'Neill as head of the quality control department.

Leo W. Ollila: Appointed director of manufacturing for the National Forge Co. Was works manager for the Wyman-Gordon Co. and prior to that manager of metallurgy for that firm's Eastern Division.

Dr. George E. Valley, Jr.: Formerly chief scientist of the U.S. Air Force and a professor of nuclear physics at Massachusetts Institute of Technology, will serve as a scientific consultant to Northrop Corp.

Dr. Jerry C. McCall: Named assistant to Dr. Wernher von Braun, director of the Development Operations Division, Army Ballistic Missile Agency. Duties will include carrying out special projects and program studies, maintaining liaison with laboratories, government agencies and industry. Joined the agency last year as a member of the scientific staff in the computation laboratory.

McCALL

W. Carlos Fox: Appointed Washington representative of Westrex Corp., a division of Litton Industries. Was previously associated with Bendix Radio Corp., International Telephone & Telegraph Co., U.S. Department of State, Commonwealth Research Corp., and Raytheon Co.

Charles F. Siebold: Formerly with Aerojet-General, joins Lockard Tool & Engineering Co., plastics division, as production manager.

Stan Burns: Named director of engineering, American Electronics, Inc. Ground Support Division, with special interest in the electronic, pneumatic and mechanical fields. Previous posts: Vice president of research and development at Marathon Electric Manufacturing Corp.; general manager, Burke Electric Co.

William J. Conner, Jr.: Appointed manager of Defense and Business Planning for General Electric's Missile and Space Vehicle Department at Philadelphia. Before joining GE in 1957, held various engineering positions at Minneapolis-Honeywell Regulator Co. and as a research physicist at the Atlantic Refining Co.

Stephen Hluchan: Recently with Taylor Instrument Co., appointed sensor and materials engineer at Bourns, Inc.

Frank R. Carvell: General manager-rocket motors for the Aviation Products Division of the B. F. Goodrich Co., replacing **Harold W. Catt,** named director of purchases and traffic for the firm in Akron. Carvell was previously production manager at the Goodrich Co. development center at Avon Lake.

CARVELL

Space Electronics Corp. has made the following appointments to its technical staff: **John J. Davis,** formerly with Aeronutronics Division of Ford Motor Co.; **Gerald R. Dunn,** from Hughes Aircraft Co.; **Donald W. Fite,** formerly with Cooper Development Corp.; **Dr. Anthony Gangi,** from the Institute of Geophysics, UCLA; **Dr. Allan Harbaugh,** from System Development Corp.; **Thomas J. Hart,** formerly Gilfillan Brothers, Inc.; **Richard M. Jaffe,** from Hughes Aircraft Co.; **Thomas C. Larter,** from Aeronutronics; **Merlin E. Louape,** Douglas Aircraft Co.; **Stephen V. Marsh,** from Hughes Aircraft Co. and **Dr. Hamilton Wright** from Jet Propulsion Laboratory.

David B. Nichinson: Former vice president - engineering, elected president of Kollsman Instrument Corp., effective April 1, succeeding **Victor E. Carbonara,** who is retiring. Nichinson for several years served as director of research and development and prior to joining the firm was a staff member with the Radiation Laboratory of Massachusetts Institute of Technology. Carbonara will continue as a consultant.

NICHINSON

William Littlewood, Vice president-equipment research of American Airlines, and **Dr. Frederick Lindvall** of the California Institute of Technology, elected to the board of directors of the Marquardt Corp., replacing the late **George P. Tidmarsh** and **Robert L. Earle,** who resigned last month.

Advertiser's Index

CLASSIFIED

when and where

MARCH

Institute of Radio Electronics, 1960 International Convention, Waldorf-Astoria and New York Coliseum, New York City, March 21-24.

American Rocket Society, Ground Support Equipment Conference, Statler-Hilton Hotel, Detroit, March 23-25.

Symposium on Optical Spectrometric Measurement of High Temperatures, sponsored by University of Chicago's Applied Science Laboratories, Jarrell-Ash Co., National Science Foundation, University of Chicago, March 23-25.

22nd Annual American Power Conference, sponsored by Illinois Institute of Technology, American Society of Mechanical Engineers and others, Sherman Hotel, Chicago, March 29-31.

APRIL

University of Connecticut, Sixth Annual Advanced Statistical Quality Control Institute, Storrs, April 3-15.

Solar Energy Symposium, American Society of Mechanical Engineers, and Mechanical Engineering Dept., University of Florida, Gainesville, April 4-5.

1960 Nuclear Congress: "What will the future development of nuclear energy demand from engineers?" includes 6th Nuclear Engineering and Science Conference; 8th NICB Atomic Energy in Industry Conference; 6th International Atomic Exposition, New York Coliseum, April 4-7.

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British Institution of Radio Engineers, Computer Group, London, April 13.

International Symposium on Active Networks and Feedback Systems, sponsored by Polytechnic Institute of Brooklyn, Dept. of Defense Research Agencies, Institute of Radio Engineers, Engineering Societies Bldg., New York City, April 19-21.

Who's Muzzling the Military?

It would be refreshing to see some responsible American military leader stand up and publicly declare that the military has a mission in space.

At this moment Congress is conducting hearings which will determine what changes are to be made in the National Space Act and what roles NASA and the Defense Department will have in U.S. space activities.

NASA will undoubtedly be given the assignment of the exploration of space for peaceful purposes but thus far the role of the military is set out in negatives. "Nothing in this act shall be construed as preventing the military from utilizing space for the defense of the country, etc."

And we hear Maj. Gen. Leighton I. Davis, Assistant Deputy Chief of Staff for Development in Air Force tell representatives of the National Security Industry Association:

"Before we go too far into the fascinating business of space, I should like to clarify the interest of the military. The President has clearly stated that it is our national policy to explore space for peaceful purposes. The Congress has wisely created the National Aeronautics and Space Administration and charged this non-military organization with the exploration job. The same act—the legislation known as the Space Act—reserves to the Defense Department those aspects of operations in space which affect the security of the United States.

"We cannot exclude space from our defense considerations. We are already in it in a very important fashion with our IRBM and ICBM weapons. And certainly, the Russian rocket which transmitted television pictures of the far side of the moon could relay back to the USSR information of places *not* too far distant.

"Whether such information has military usefulness depends upon progress in electronics—so we are right back again on the importance to our defense position of dynamic progress in science and technology."

We cannot really believe that a two-star general whose assignment and duty it is to develop the future weapons of the Air Force would stand up and with a straight face make a statement like "we cannot exclude space from our defense considerations" unless he were under orders to say nothing else.

Or that he would seriously maintain that the value of reconnaissance pictures of the backside of the moon would depend on the progress of electronics—unless he was prevented from saying more.

We have been hearing a great deal lately about a single agency for space; a cabinet level secretary for space.

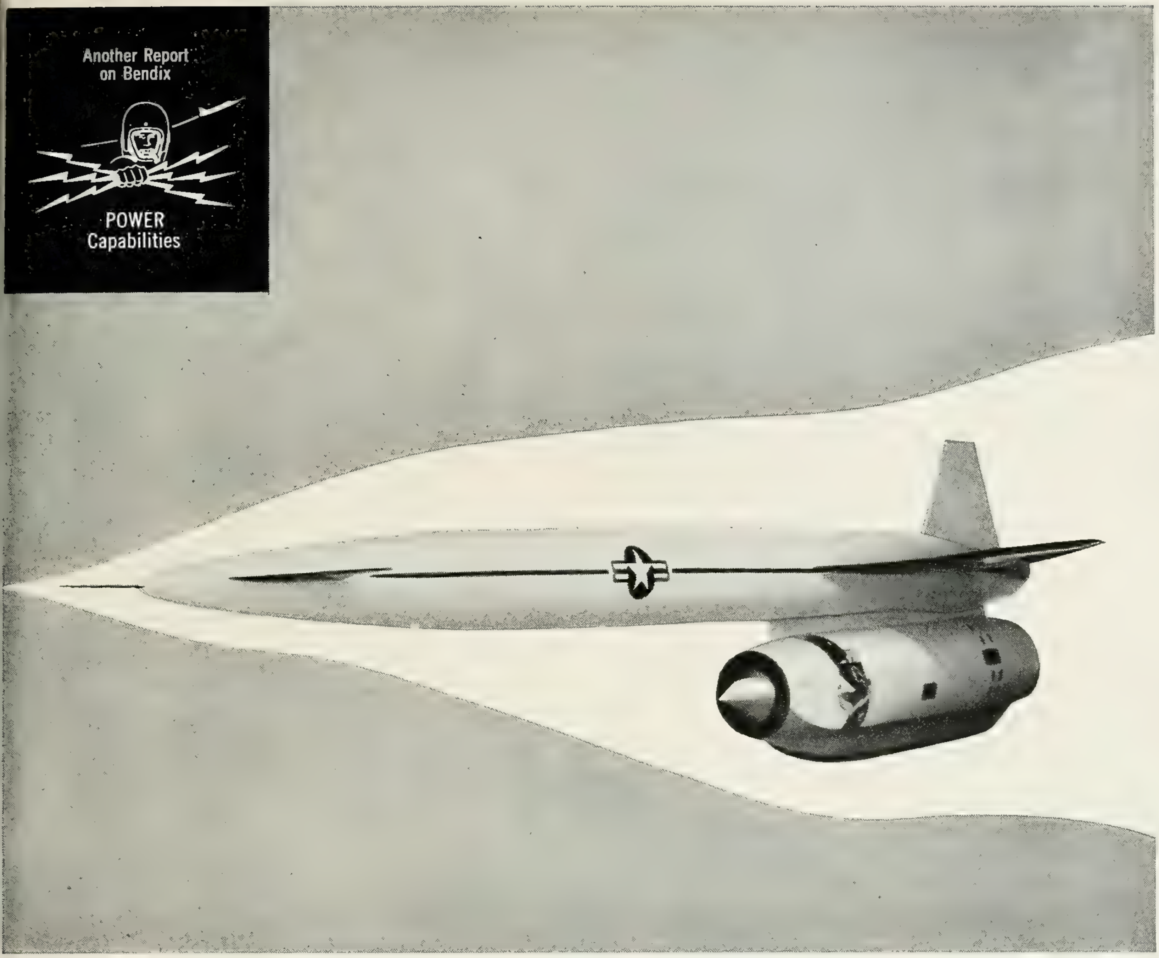
Space is not a project. Space is a place—an area. We no more need a single agency for space than we need a single agency for the sea—or for the South Pole.

In the years ahead a great many government agencies (like Commerce and State) will have business in space right along with NASA. And so, we hope, will a great number of U.S. industries (like Space Communications, Inc., and Space Travel, Inc.).

And in these years ahead there is also the mission of the military—to so plan and so build that it can defend space against any nation or group of nations who would deny the free world peaceful access to it.

We have declared that it is our national purpose to help explore and develop space for peaceful purposes. Are we naive enough to believe that man's predatory instincts will change once he leaves the atmosphere? That peace won't have to be defended? That the military shouldn't be given this defense mission now, clearly and unequivocably so they can begin planning for it, 10 and 20 years ahead?

Clarke Newlon



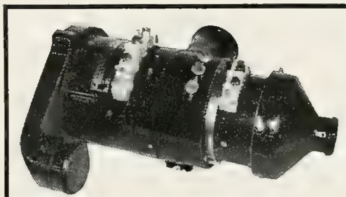
The GAM-77 "Hound Dog"—North American Aviation's Missile Division, prime contractor.
This air-to-surface missile is carried by heavy bombers of USAF's Strategic Air Command.

BENDIX AC/DC PACKAGE GENERATES DEPENDABLE IN-FLIGHT ELECTRICAL POWER FOR "HOUND DOG"

The "Hound Dog" missile adds still more reach and punch to SAC's long arm. Carried by a B-52 bomber, the missile can be launched several hundred miles away from the target, and is capable of delivering a nuclear payload.

Before launching, the missile's electrical needs are supplied by the mother ship. Once "Hound Dog" is on its own, a Bendix® AC/DC generator fully meets electrical power demands. In a great new breakthrough in voltage control, the unit is equipped with a Bendix transistorized static AC/DC voltage regulator. The DC capacity of this Bendix AC/DC generator is provided with an addition of only five pounds in generator weight. Here is another example of the Bendix Red Bank concept of lightweight, reliable AC/DC power packages.

Get further details from RED BANK GENERAL PRODUCTS DEPARTMENT.



"Hound Dogs'" Bendix AC/DC Generator, a brush-type unit rated at 9 KVA, 3 phase, 400 cycle, 120/208 volts AC; 60 amps, 28 volts DC.

GENERAL PRODUCTS DEPARTMENT

Red Bank Division

EATONTOWN, NEW JERSEY

Bendix
AVIATION CORPORATION

West Coast Office: 117 E. Providencia, Burbank, Calif.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliate: Aviation Electric, Ltd., P.O. Box 6102, Montreal, Quebec

Circle No. 18 on Subscriber Service Card.

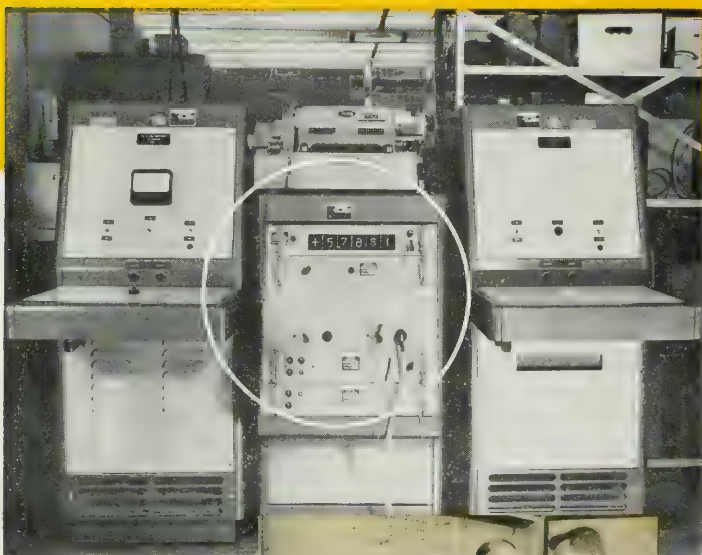
ELECTRO INSTRUMENTS can meet your systems needs NOW... with HARDWARE, NOT PROMISES!

Systems shown here are typical of more than 200 designed and built by EI and now in use. They range in complexity from data logging systems for automatic scanning, measurement and recording of data from multiple transducers...to high speed, automatic checkout systems for missile and aircraft...to systems for automating industrial processes.

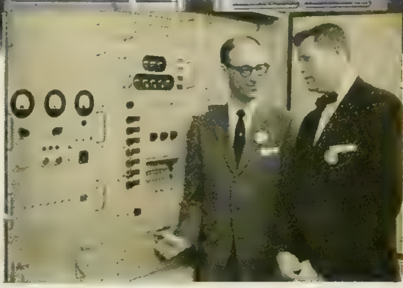
Because of the EI modular design approach, many of these systems can be delivered on virtually an off-the-shelf basis, eliminating the long delivery times usually associated with system development. This approach also results in a low cost system because the modules are manufactured in large quantities. Cost is almost a linear function of performance capabilities desired.

Why not talk over your digital system requirements with your EI Sales Engineer? His system experience will be a valuable help in solving your problem.

Multi-purpose digital system for measuring a variety of transistor parameters while the transistors are being subjected to environmental testing.



Digital read-out sub-system of a large, automatic, transistor production checkout system.



Sub-system for the ground support equipment on the B-58 **Hustler** program. Measures AC and DC single-ended voltages and ratios, and AC and DC differential voltages and transients. Chosen for its excellent operating characteristics under adverse environments.

you get MORE with EI systems!

MORE VERSATILITY—AC and DC voltages, AC and DC voltage ratios, ohmic resistances, capacitance, frequency, phase, inductance, time, or combinations of these basic input quantities can be accepted by the EI system.

MORE RELIABILITY—Maximum use is made of solid-state and MIL-type components which are designed into conservatively-rated, field-proven circuits. All vendor-supplied parts are exhaustively tested and evaluated.

MORE FLEXIBILITY—Expansion of the EI system can be made by simply adding appropriate new modules. This approach eliminates new engineering development costs each time needs change; minimizes system obsolescence.

Electro Instruments, Inc. EI 3540 AERO COURT SAN DIEGO 11, CALIF.

DIGITAL INSTRUMENTS FOR MEASURING AC DC VOLTAGES, AC DC RATIOS, RESISTANCE, CAPACITANCE, AND FREQUENCY • X-Y RECORDERS & ACCESSORIES • DC AMPLIFIERS

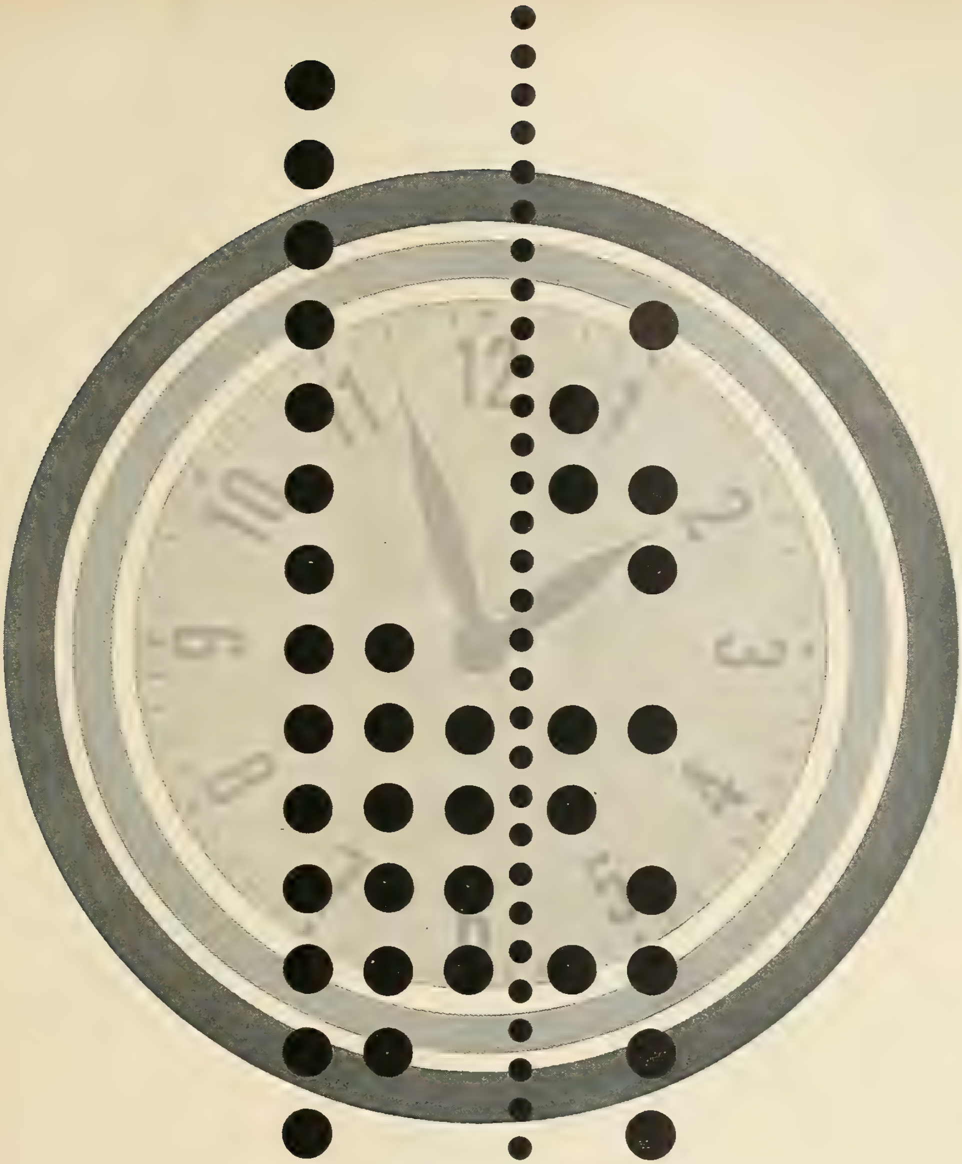
MARCH 28, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

Honeywell's Compass for Astronauts

AN AMERICAN AVIATION PUBLICATION



—when and where—

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Society of Plastics Engineers, North Texas Section, Annual Regional Technical Conference, Hotel Texas, Fort Worth, April 20.

Symposium on Electrical Conductivity in Organic Solids, Air Force Office of Scientific Research and Office of Naval Research, Duke University, Durham, N.C., April 20-22.

Royal Aeronautical Society, "On Reducing Costs of Space Research," London, April 21.

THE MISSILE/SPACE WEEKLY

missiles and rockets

Volume 6 No. 13

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Leonard A. Eiserer, Exec. Vice President
Fred S. Hunter
Vice Pres. and Editorial Director

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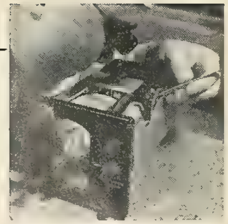
THE COVER



"Space Compass" developed by Honeywell for Project Mercury *capsule will enable astronaut to tell instantly his precise position relative to earth* *(see p. 28).*

MARCH 28 HEADLINES

ASTRIONICS

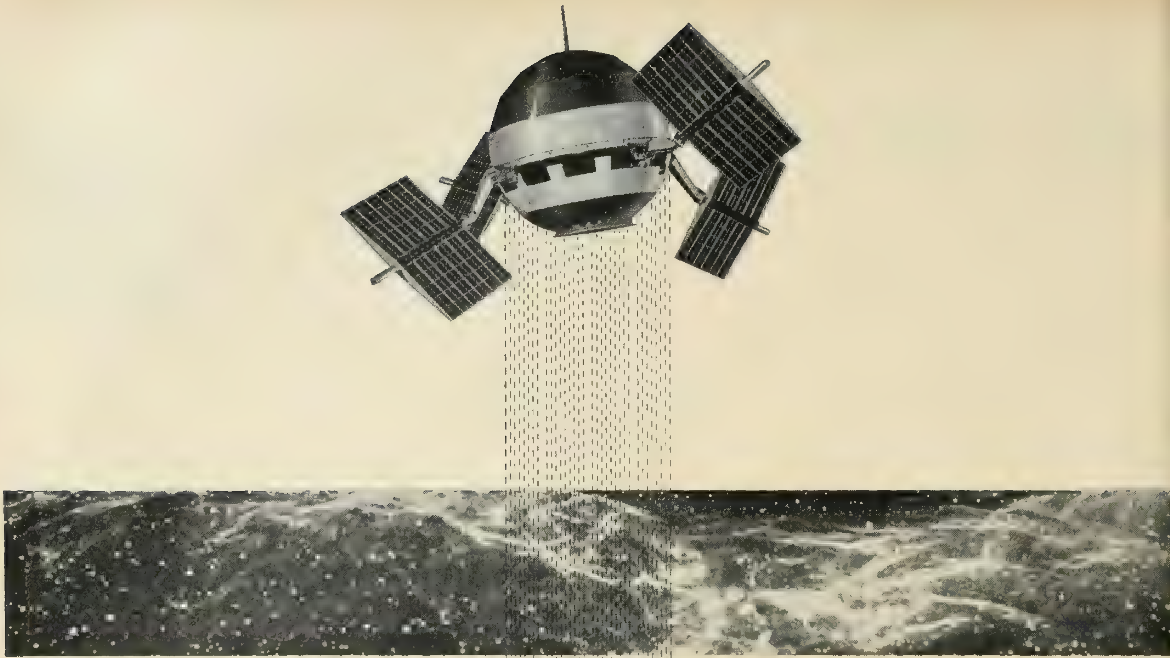
PROPULSION ENGINEERING

ADVANCED MATERIALS

INTERNATIONAL

PRODUCTS AND PROCESSES

DEPARTMENTS



Pioneer V
Paddlewheel Planetoid
Is Vaulting
Through Unexplored Space
Toward The
Orbital Path of Venus

At this moment Pioneer V, one of the most advanced space probe vehicles ever launched, is on a course toward the path of Venus—26 million miles from earth. Blasted aloft March 11 by a Thor Able-4 rocket booster, this miniature space laboratory will reach its destination in about 130 days.

The project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, may confirm or disprove long-standing theories of the fundamental nature of the solar system and space itself.

Energy from the sun—captured by almost 5,000 cells mounted in the four paddles—is used to supply all of the electrical power to operate the sophisticated array of instrumentation packed into the 94-pound spacecraft which measures only 26″ in diameter.

By combining a phenomenal digital electronic brain (telebit) with a powerful radio transmitter inside the satellite, STL scientists and engineers expect to receive communications from Pioneer V at their command over interplanetary distances up to 50 million miles.

STL's technical staff brings to this space research the same talents which have provided over-all systems engineering and technical direction since 1954 to the Air Force missile programs including Atlas, Thor, Titan, Minuteman, and related space programs.

Important positions in connection with these activities are now available for scientists and engineers with outstanding capabilities. Inquiries and resumes are invited.

SPACE TECHNOLOGY LABORATORIES, INC.

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Cape Canaveral • Manchester, England • Singapore • Hawaii

P. O. Box 95004, Los Angeles 45, California

Washington Countdown

IN THE PENTAGON

The long shot . . .

of a Convair *Atlas* 9000 miles across the Atlantic to the Southern Indian Ocean is looked for about the end of April. The trajectory will carry the big ICBM over water all the way. However, it will pass near Brazil and South Africa.

• • •

Reduced payload . . .

will account for most of the extra range in the 9000-mile shot aimed at taking some of the propaganda value out of Russia's shot into the mid-Pacific. But the two shots are not comparable: The *Atlas* will have a thrust under 400,000 pounds; the Soviet missile is estimated to have had upwards of 1 million pounds of thrust.

• • •

Project *Advent* . . .

is ARPA's new name for three of its communication satellite projects—polar-orbiting satellites *Steer* and *Tackle* and 24-hour satellite *Decree*. ARPA's *Courier* communications satellite remains as a separate project. The agency says no change in funding or schedules is involved.

• • •

Dummy Lockheed *Polarises* . . .

for use in system checkouts and training aboard *Polaris* submarines are undergoing preliminary underwater launching off San Clemente Island, Calif. The operational-scale dummies—nicknamed *Dolphins*—clear the surface by only a few feet and fall back into the water where they are recovered.

ON CAPITOL HILL

Concern is mounting . . .

among members of the House and Senate Space Committees as to whether the Administration's proposed changes in the National Space Act go far enough. Some committee members are saying that the changes only recognize legally the status quo.

• • •

A hot floor fight . . .

is expected in the House over the new bill aimed at curbing the employment of recently retired military officers by defense contractors. A group of congressmen including Rep. Alfred Santangelo (D-N.Y.) will move for a much tougher bill.

Big money boosts . . .

are now expected by many insiders to be enacted by the House for the *Atlas, Polaris, Titan* and *Minuteman* programs—and possibly the B-70. The Senate probably will go along with most of it.

AT NASA

Astronaut escape training . . .

has convinced the *Mercury* team that the first man into space will leave his capsule only in case of extreme emergency. Lying flat on his back, the Astronaut must remove the instrument panel, push the empty parachute can out the escape hatch, and wriggle through a 16-by-32-inch hole into his inflatable raft. The Astronauts have had great difficulty attempting this in Langley's hydrodynamic test tank.

• • •

NASA's payroll . . .

will reach 16,373 early in the next fiscal year—more than double the payroll of the old NACA around which NASA was formed. Major additions are 5500 at Huntsville's George C. Marshall facility and 2000 at the new Goddard center.

INTERNATIONAL

Tartars for the Japanese Navy . . .

are reported to have been purchased from Convair. Japan bought the new surface-to-air missiles for its latest 2600-ton destroyers.

• • •

A Malta missile depot . . .

is being planned by the British. The depot in the strategic Mediterranean will be used for surface-to-air *Firestreaks* and *Seaslugs*.

• • •

An Anglo-German deal . . .

on the surface-to-air *Seacat* is understood to be under consideration. Under the proposal, Focke-Wulf would handle testing, maintenance and guidance work for the British missile.

• • •

Russia's next move . . .

in space is expected to precede the Summit meeting May 16. Some are guessing that the Russians will put the first man into orbit.

Radioplane's RP-76, holder of the world's altitude record for operational target missiles.

Industry Countdown

MANUFACTURING

Shift of Louis Michelson . . .

from manager of General Electric's Rocket Engine Section, Evendale, Ohio, to a special assignment has taken place as part of a shake-up of the company's Flight Propulsion Division. W. B. Boyd has been moved over from division manager of manufacturing to replace Michelson on a temporary basis. The section was hit by the recent cancellation of NASA's *Vega* project and its only major contract at present is development of a second-stage rocket case for *Minuteman*.

• • •

A top-secret missile . . .

project is reported under negotiation between Convair and de Havilland.

• • •

Some 6500 Convair . . .

employes covered by Engineers and Architects Association contracts are expected to okay demands for a 10% package increase in wages and benefits before EAA opens negotiations with the company about May 28. EAA's present agreement expires June 2.

• • •

Main bargaining point . . .

in the upcoming industry-wide labor negotiations this spring may be employment. Management is expected to stress that overall defense industry employment is down, in an effort to hold the line on rising fringe benefits.

PROPULSION

Insiders say NASA is trying . . .

to grab full control of the Joint AEC-NASA Project *Rover* nuclear rocket. NASA Administrator T. Keith Glennan is said to be seeking the transfer of all key *Rover* administrative people from AEC headquarters at Germantown, Md., to NASA. AEC is fighting the move strenuously at a series of high-level meetings in Washington.

• • •

Boost-glide passenger . . .

space transport is predicted in the 1980-90 decade by Leston Faneuf, Bell Aircraft Chairman. He foresees vehicles similar to *Dyna-Soar* carrying 30 persons and a crew of five to any point on earth within an hour. Fares would be comparable to those on today's jets.

DuPont's interest in . . .

metals processing is on the upswing. It has just taken on an Air Force contract to look into the extrusion of niobium.

ASTRIONICS

Belock Instrument . . .

is proceeding with plans to open a new facility at Huntsville—despite some uncertainties that have cropped up. Biggest question mark is Dr. Frederick K. Mueller and the other German scientists Belock says will staff the new operation. Mueller and the others have not yet resigned from Dr. Wernher von Braun's ABMA-NASA team, or said they will. Von Braun has expressed doubt whether the new Belock subsidiary will receive any business from NASA.

• • •

Look for a significant . . .

breakthrough in radar technology to be announced by DOD shortly. The development, called "synthetic aperture," achieves equivalent antenna lengths up to one mile in small light-aircraft antennas.

• • •

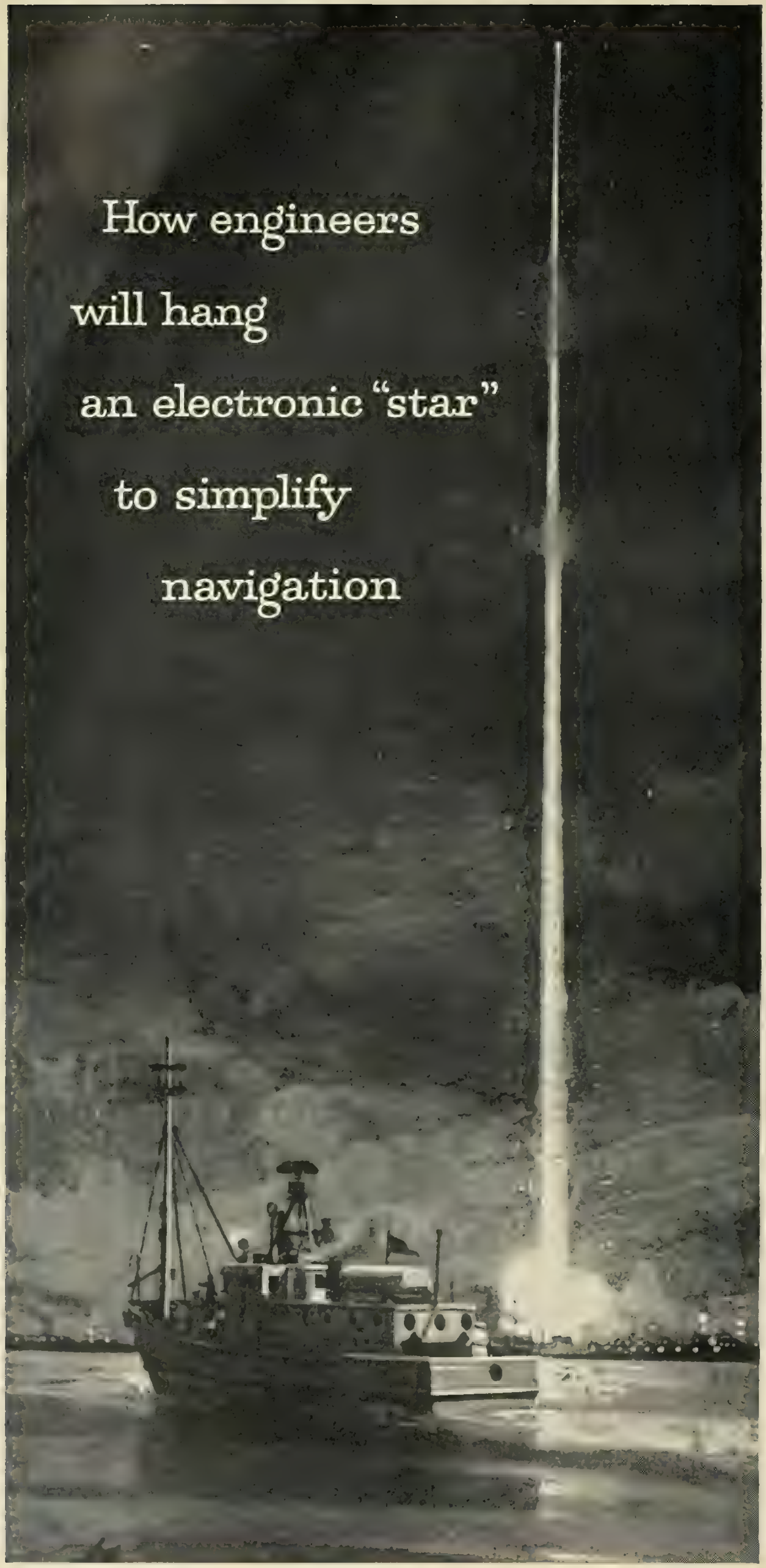
Successful tests of plastics . . .

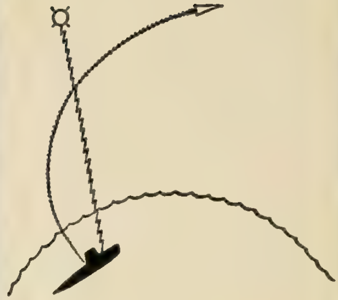
at temperatures up to 2000°F in long-period hypersonic wind tunnel experiments are being reported by Temco aircraft.

WE HEAR THAT

Merger of The Martin . . .

Co. and General Precision Equipment is expected to be fully negotiated this spring. Martin already owns 20% of GPE stock . . . Strong feeling is developing in Britain's defense ministry against cancellation of the *Blue Streak* IRBM . . . Ryan's *Firebee* target drone is being eyed by foreign nations, including Britain . . . Assembly and supply depot for the *Polaris* Atlantic fleet will begin operations April 1 at Charleston, S.C. . . . Fabrication is starting on the 310-ft. mobile service tower for *Saturn* following completion of designs by Kaiser Steel.





Anyone who has ever groped his way in the dark or navigated a ship in a fog will appreciate the promises this Space Age project holds forth . . .

A satellite program is now in development to improve the ancient art of celestial navigation.

A network of solar-battery satellites will encircle the earth, continually transmitting data that can let ships and aircraft figure their positions simply by tuning to the satellites. Submarines and long-range missiles may also use the system.

While the satellite network is still in development, Douglas *Thor*—the booster that can lift it into space—is already operational. It has proved highly reliable as the prime booster in the Air Force "Discoverer" firings and launched the first nose cone recovered at ICBM range.

Thor is another product of the imagination, experience and skill Douglas has gained in nearly 20 years of missile development.

The dependable Douglas *Thor*, prime booster in new multi-stage missiles, can launch satellites—or shoot for the moon.

DOUGLAS

MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • TRANSPORT AIRCRAFT • AIRCOMB® • GROUND SUPPORT EQUIPMENT

M/R Gets New Space Age Cover

For the past nine months we've been studying designs for a new M/R cover . . . designs submitted by several of the country's leading magazine layout specialists.

One problem became the location of the M/R signature; should it stay at the bottom of the cover page, or should we move it to the top? Opinions varied; one group of M/R staffers felt that a basic change in cover design might destroy the magazine's image. Others, the writer among them, had seen M/R's name obscured so often (due to its former location at the bottom of the page) in engineering departments, libraries, magazine racks, and on desks and coffee tables, that we crusaded for a change.

A noted business publication layout expert, Bill Watson, solved our problem by submitting, among two dozen others, the design which made its debut this week. We think he did a great job, and that we made a wise choice. But the cover, like the rest of M/R, belongs to you, the reader. Let's hear what *you* think.

Keeping pace with a market moving as fast and changing as rapidly as does the missile/space market requires neat footwork and a sharp eye on industry developments. Since M/R was first published four years ago, the market has expanded . . . up into space and down beneath the surface of the ocean.

Therefore, to better reflect the real meaning of the magazine, M/R has a new sub-title this week, "The Missile/Space Weekly," appearing on the cover and on the Table of Contents page.

And as part of M/R's continuing effort to keep you abreast of industry developments, we move beneath the waves with the establishment of a new section on Antisubmarine Warfare Engineering, to bow in the near future.

In this latter connection, we're proud to announce two additions to the M/R staff of missile/space market editorial experts: Vice Admiral Harry Sanders (USN, Ret), Director of Chance Vought's ASW Engineering Department, who will become M/R's ASW Engineering consultant and the newest member of our editorial advisory board; and William Beller, industry consultant, author and former Managing Editor of Aero Digest, who will serve as M/R's Engineering Editor, and who is already deep in research on the ASW Engineering problem. (For more on these appointments, see page 16.)

In his letter accepting the M/R editorial advisory board appointment, Admiral Sanders wrote, "The magnitude of the management and engineering problems in Underseas and Antisubmarine Warfare is very great. The difficulties are accentuated by scientific problems as complex and nebulous as any in the whole area of defense . . . problems such as detection and underwater communication (which) have emphasized the need for a scientific breakthrough. The subject is vast in scope and I'm sure that Missiles and Rockets can do much to help both industry and the Armed Forces within the confines of whatever editorial policy you decide upon."

We're grateful to Admiral Sanders and are confident that he, as one of the world's foremost authorities on ASW Engineering, will assist us with these missions.

He'll have a lot of help from the M/R staff. Managing Editor Don Perry, a Navy veteran, has an impressive background in submarine warfare. He qualified in submarines in 1942 and served six years with the underseas fleet, mostly on Pacific Theatre war patrol. Electronics editor Hal Gettings, a former Navy electronics officer with more than ten years' experience in engineering and writing, was responsible for the special Underseas Warfare report in M/R's Aug. 10, 1959 issue, regarded by many in the Pentagon as the outstanding interpretive job to date on this subject.

This week's issue incorporates other, less noticeable changes we believe will make easier your weekly reading of M/R. We've decided to concentrate technical editorial subject matter into departments, so look for electronics, propulsion engineering, ground support equipment, advanced materials, ASW Engineering and international sections each week from now on. Editorial space limitations may prohibit the appearance of every section every week, but over the course of each month you will find the latest news and technical development reports in each category.

The key word in the missile/space market has always been FLEXIBILITY . . . flexibility to meet the challenge of changing technology; flexibility of management and R&D teams to come forth with new concepts; flexibility of industry to establish systems and components requirements often before many in government realize the need for such requirements.

Flexibility within the missile/space market has resulted in continually improving missile and space systems. Flexibility on the part of Missiles and Rockets, The Missile/Space Weekly, will result, we hope, in a continually improving editorial product.

Edward D. Muhlfeld

letters

Storables Interest Grows

To the Editor:

I would like to obtain three reprints of Dr. C. M. Beighley's article, "Storables Stir Renewed Interest," which appeared in the Feb. 15 issue of MISSILES AND ROCKETS.

Stanley F. Sarner,
Rocket Thermodynamics Specialist,
General Electric Company,
Cincinnati

On their way—Ed.

Gracious Subscriber

To the Editor:

Thank you for your gracious words on my retirement. I still subscribe to MISSILES AND ROCKETS and hope to keep abreast of the fast-moving developments in this field through your publication.

H. N. Toftoy,
Maj. Gen., USA (Ret.)

The Way Things Are

To the Editor:

With reference to "What Industry Says" on page 19 of your March 14 issue:

1. Thomas J. Lanphier and Senator Symington are correct.
2. Mr. Eisenhower is a fool.
3. The Pentagon, in general is a collection of fools; always has been, and always will be.
4. It is now possible for people entirely outside the Defense Department or industry to build 20 to 50 kiloton boosters within two years using existing construction techniques and conventional fuels.
5. Terminal velocities of our larger boosters can be increased by 4000 to 8000 feet per second by a simple modification.
6. First-stage propulsion effort is limited only by strength (not weight) of subsequent rocket stages.

Herman L. Moor
261 State Street
Hackensack, N.J.

Tell us how, Mr. Moor.—Ed.

Credits Corrected

To the Editor:

I wish to call to your attention some inconsistencies and improper credits in the article entitled "Automatic Test Equipment Burgeons," in your Feb. 29 issue.

The graph on the bottom of p. 49 shows EPSCO as a supplier of test equipment to the *Terrier/Tartar* programs. They have supplied component parts such as memory units and analogue to digital converters of test equipment systems, but have never supplied complete systems.

On p. 52, the credit for the BOFTE system belongs to HYCON Manufacturing Co., which also furnished the AN/DSM-54 and-55 for *Terrier/Tartar*. The BOFTE is programed in a fixed sequence with stepping switches.

Convair-Pomona has automatic systems in use in our production line that are card-programed and do perform as indicated in your article. In addition, Convair-Pomona has supplied the AN/DSM-23 which is used for USMC checkout of *Terrier* missiles. This equipment is a tape programed system with a programable analogue voltage comparator and RF guidance simulator.

E. L. Watkins, Chief,
Support Systems Equipment Section
Convair Pomona

Barnes' DAMP Contribution

To the Editor:

As an avid reader of your excellent publication, I was particularly interested in the Feb. 29 issue which carried an article on page 22 entitled, "*Arcas* Launchers Put on Army's Range Ship." However, we were somewhat surprised to note that no mention was made of Barnes Engineering Company's continuing contribution to the DAMP Program.

Barnes Engineering, under prime contract to ARGMA, is responsible for the optical measurements portion of the DAMP project.

Edmund B. Palmquist
Barnes Engineering Company
Stamford, Conn.

Linde's LOX Policy

To the Editor:

I think you will be interested in the response accorded your recent article concerning liquid oxygen supplied to the missile industry. In general we felt that the treatment given the subject was entirely objective and factual. It certainly covered the subject to a more extensive depth than prior articles in "popular nontechnical publications."

Naturally, an article such as this one could not help but raise some issues with respect to the companies included. The only issue raised within Linde Company, however, was a feeling that your audience might possibly misunderstand our position concerning liquid oxygen supply to the government. Although all of our contracts thus far have specified liquid oxygen via the delivered route, Linde is not committed in any one direction and will use the most efficient method to supply government installations. Feasible methods, of course, include piping the product from "over the fence" plants, and even building a plant to be sold or leased to the government and operated by government personnel or by non-government personnel under contract.

A. Kiczales
Advertising Department
Linde Company, Div. of
Union Carbide Corp.
Room 2840
420 Lexington Avenue
New York 17, N.Y.

 Circle No. 9 on Subscriber Service Card.

Project *SLAM* Awaits Go-ahead

Air Force evaluates design studies of low-altitude ICBM which might foil Soviet defenses; decision up to DOD

by William J. Coughlin

LOS ANGELES—Design studies for an intercontinental supersonic low-altitude missile powered by a nuclear ramjet engine—Project *SLAM*—have been completed and now are being evaluated by the Air Force.

Fate of Project *SLAM* will rest with a Department of Defense decision whether or not to proceed with research and development on another major missile program at this time.

Project *SLAM* envisions a missile with Mach 3 sea-level speed which will have unlimited intercontinental range and which will be capable of low-altitude approach to a target from any direction. Unlike the ballistic missile, it will be able to feint and dodge as it approaches target.

Launched from mobile bases in the U.S. or elsewhere by rocket boost, the *SLAM* missile would cruise to target in a corridor between 50,000 ft. and 100,000 ft. at speeds up to Mach 4 before diving to approach Soviet territory at Mach numbers between 2 and 3. Alternatively, the entire mission could be accomplished at low altitude if required.

SLAM will be capable of carrying multiple-warhead payloads and since, unlike a ballistic missile, its guidance system can monitor and correct its position throughout the flight, it will be able to achieve extremely high accuracy. No major breakthroughs in guidance are required.

• **Poser for Reds**—*SLAM's* long-range capability, supersonic speed, low-altitude and omni-directional approach would impose requirements on the Soviet defense system which it has not yet had to meet, military experts believe. Intelligence reports indicate the Russian missile warning network, like that of the U.S., is designed to cope primarily with ballistic missile trajectories.

One study for the *SLAM* project indicates that present Russian radar would be unable to pick up approach of the missile at 1000-ft. altitude until it was within 20 miles. Instantaneous response by an antimissile missile would be unable to destroy *SLAM* until it was within six miles of target—destructive range with a high-yield hydrogen warhead. Kill probability even then only would approximate 10%, the study indicates.

Initial *SLAM* design studies were made by North American Aviation, Convair and Chance Vought.

Experimental development of the nuclear ramjet engine, under way since early 1956 as Project *Pluto,* is being carried out by the Atomic Energy Commission's Lawrence Radiation Laboratory at Livermore, Calif., by Marquardt Corp. at Van Nuys, Calif., and by the Atomics International Division of North American Aviation.

LRL is responsible for the reactor and Marquardt, under Air Force contract, is developing non-nuclear components of the system.

Advanced materials research for *Pluto* is being done at Atomics International under an AEC contract. Major problem for the nuclear ramjet missile is development of materials capable of withstanding the high temperatures and radiation encountered.

• **Modest funding**—AEC expended some $27 million on the nuclear ramjet program through Fiscal 1959 and the Air Force $10 million. This compares with a total of some $880 million spent on the nuclear manned-aircraft program.

Air Force interest in the program is high. Gen. Thomas D. White, AF Chief of Staff, has this to say:

"Studies completed on nuclear ramjet proposals offer promise of low-altitude, high-speed, long-range missiles that can augment our strategic ballistic missile forces . . . the existing programs in development of nuclear missile propulsion are now in proof-of-principle status . . ."

The first *Tory-2* experimental reactor developed under the U.S. nuclear ramjet program is scheduled for testing shortly at AEC's Jackass Flats, Nevada, test site. This reactor built at Lawrence Radiation Laboratory is intended to prove out development of high-temperature gas-cooled reactor materials, neutronics and other design features.

Building of a full nuclear ramjet engine prototype still is some distance off. Funds for building of test facilities are included in the AEC budget for Fiscal 1961.

• **Direct cycle**—The engine for *SLAM* will be a direct-cycle unit in which the ram air is passed through a series of honeycomb holes in the cylindrical reactor. The reactor replaces the fuel injector and combustor of the conventional ramjet engine and is similarly situated. Supersonic inlet of the engine will be a simple conical spike with a pressure ratio of about 37/1 at Mach 3, more than 100/1 at Mach 4.

As the air passes through the "Swiss cheese" reactor structure, its temperature will be raised by nuclear heating and it then will be expelled through a conventional exit nozzle.

The reactor itself will be a homogeneous moderated reactor. (In a homogeneous reactor, the nuclear fuel is mixed with the moderating material.) A core reflector will be used to make possible a more uniform radial heat distribution. Controls will be largely pneumatic.

Reactor diameter will be large, as much as six feet, since increasing the dimensions beyond those of a conventional ramjet means a larger amount of air will flow through, increasing thrust with no penalty to speak of in increased consumption of nuclear fuel.

• **Vital statistics**—Dr. Theodore C. Merkle, Associate Director, Lawrence Radiation Laboratory, indicates in an article in the Fall-Winter issue of the Air University Quarterly Review that the open area of the multi-channeled cylindrical reactor will be about half the area of one end of the cylinder. Length of the reactor will be about equal to its diameter and the length-to-diameter ratio of the holes about 200.

In the same publication, Alan R. Gruber, Director of the Nuclear Systems Division of Marquardt, calculates that a nuclear ramjet engine with a six-ft. reactor diameter, delivering air at 1840°F, would provide 13,200 lbs. thrust for a missile with a speed of Mach 3 at 60,000 ft.

"Assuming that a lift/drag ratio of 4 could be achieved for a missile with this engine installed," Gruber says, "the missile's allowable gross weight would be 52,800 lbs. If we further assume that the missile structure weighs 35% of the gross weight, or 18,500 lb., and that the engine and its controls weigh 20,000 lb., then we find that a balance of 14,300 lbs. is available for useful load."

• **Strain on structures**—An increase in reactor temperature to 2240°F could bring the engine thrust to about 18,000 lbs., upping gross weight of the missile to approximately 72,000 lbs., and useful load to 26,800 lbs. It is apparent from this that the critical limitation in design of the nuclear ramjet for *SLAM* is the high temperature which the struc-

tural material of the reactor itself must withstand. On-the-deck aerodynamic heating also must be considered, as well as the fact that the reactor will have to stand a pressure across its face of 550 psi at Mach 3 at sea-level.

Present workable metal alloys are unable to meet the high-temperature structural requirements. Materials meeting temperature specifications present fabrication problems.

Friction losses of air moving through the many channels of the reactor also will be greater than the losses in the combustion chamber of a conventional ramjet engine.

Due principally to these two factors, specific thrust of the nuclear ramjet is inferior to the conventional ramjet. This can be offset to some extent by increasing dimensions of the engine.

• **Other problems**—Capt. John P. Wittry, an Air Force advanced propulsion technologist, reports in the Air University Quarterly that the biggest problem in development of the direct-cycle *Pluto* engine, where air passes directly over the hot elements in the reactor core, is oxidation. This causes materials to lose structural integrity.

Shielding for *SLAM* is a much smaller problem than for a nuclear-powered manned aircraft, although shielding of the missile still is a requirement. Radiation is sufficiently intense to prevent use of certain materials in the propulsion system and the missile.

Even at very low altitudes, however, passage of the *SLAM* missile overhead will pose no radiation problems on the ground since a typical mission will result in distribution of only a few grams of fission products over many thousands of miles.

U. S. Space Plans Slip Everywhere

by James Baar

The U.S. Space Lag is even worse than some critics have said it is.

Not only is the United States behind Russia in space, the United States also is slipping far behind the schedule of space exploration that some of its best minds believed possible nearly a year and a half ago.

At that time, the original Select House Space Committee polled dozens of the Free World's leading scientists, engineers and government officials in charge of space activities as to what they thought the U.S. could accomplish in space by the end of 1968.

The poll — subsequently compiled and issued Jan. 2, 1959, as a report called "The Next Ten Years in Space, 1959-69"—makes a handy yardstick for measuring current U.S. space plans.

Slippages show up everywhere. In some vital areas, the recent 10-year space program advanced by NASA (M/R, Feb. 8) is already five years behind some estimates.

On the prime goal of putting a man on the moon there is anywhere from a three to seven year lag compared to NASA's target date of about 1972.

Twenty of the experts polled in the survey said the U.S. could land a man on the moon by 1968 at the latest. Many of the 15 others commenting on lunar exploration felt a manned lunar landing would be near by then.

Dr. Herbert F. York, now Pentagon R&E Director and then Chief Scientist of ARPA, said a very high priority program could put Americans on the moon in 1965 and on Mars and Venus in 1968. Such a schedule would beat the announced Russian plan to land men on the moon by late 1967.

Others without specifying what years said the United States could put a man on the moon and bring him back before the end of 1968. Among these were: Lt. Gen. Bernard A. Schriever, commander of the Air Research and Development Command; Dr. Louis G. Dunn, president of STL; Dr. Walter Dornberger, technical assistant to the president of Bell Aircraft; Dr. James H. Doolittle, then chairman of the National Aeronautics and Space Council; George S. Trimble Jr., vice president of Martin; Brig. Gen. Homer Boushey, Air Force Advanced Technology director.

Event	NASA	House Poll
MAN IN ORBIT	1961	1959+
1.5-MILLION LB. THRUST BOOSTER	1963	1961
UNMANNED CIRCUMLUNAR FLIGHTS	1964	1961-3
MANNED CIRCUMLUNAR FLIGHTS	1969+	1965-68
MANNED SPACE STATIONS	1969+	1965-68
MAN ON MOON	1972	1965-68

COMPARISON of the current NASA timetable and opinions expressed in the year-and-half-old survey of experts made by the House Space Committee.

The NASA timetable—billed as a guideline subject to revision either forward or backward depending on funding and scientific progress—calls for firing a three-stage *Saturn* vehicle in FY 1963. The clustered booster would have 1.5-million pounds of thrust.

But Dr. Eric Durand, Aeronutronics' chief of space sciences, said a clustered 1-million pound thrust booster could be operational in calendar 1961 and a single chamber 1-million pound thrust booster could be operational by 1963. Boushey said a recoverable 4-million pound booster could be developed before 1964. George Stoner, Boeing manager of *Dyna-Soar* systems, said a 1.5-million pound thrust booster could be developed by the end of 1961.

The NASA timetable calls for putting the first manned satellite in orbit in the later half of 1961. Some of the experts polled said it could have been done by last year.

The NASA timetable calls for putting an unmanned satellite around the moon and bring it back in 1964.

But according to Schriever's proposed schedule the United States could be sending a man around the moon within about the same time period. George L. Haller, vice president of General Electric, said a soft lunar landing by an unmanned vehicle was possible by the end of 1961 at latest.

The NASA timetable calls for the first launchings between FY 1965 and 1967 leading to manned space stations and manned circumlunar flights.

But a number of the experts polled said the United States could have space stations in operation by the end of 1968 at the latest. Schriever said three-man space stations could be in orbit around the earth by around 1965.

They came up with approximately the same time period—1965 to 1968—for manned circumlunar flights. And they said such flights would be preceded by a controlled manned space flight.

The key to all of the forecasts in the committee report was money.

York based his most conservative schedule "on the assumption that expenditures will average very roughly $1 billion per year and that vigorous related programs of a military nature such as the missile and high speed aircraft programs will continue at more or less their present rate."

Durand based his forecasts on a total expenditure of about $30 billion over the 10-year period; Schriever on "relatively large amounts of resources;" others put the cost at about $20 billion; still others said bluntly:

The United States can have these things if it will pay the price.

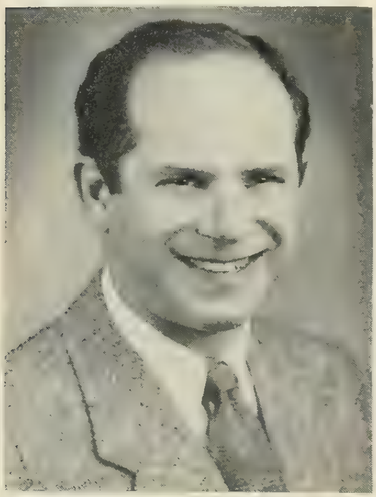
M/R Expands Its Coverage of ASW, Technology Fields

Antisubmarine warfare expert joins board of advisors; veteran engineering writer-consultant added to staff

Two authorities in the missile/space field joined MISSILES AND ROCKETS last week to lend support to the magazine's expanding editorial coverage in the antisubmarine warfare and astronautical engineering areas.

Vice Admiral Harry Sanders, USN (Ret.) accepted appointment to the magazine's Editorial Advisory Board in the field of Antisubmarine Warfare Engineering. M/R in its April 11 issue begins a new department—ASW Engineering—with regularized coverage of this vast new field where the technological problems parallel those of missiles and space.

ADMIRAL SANDERS
CV's top ASW expert joins M/R's board.



WILLIAM BELLER
New M/R Engineering Editor.

William Beller, who has an impressive background as a scientific consultant and writer, joins the full-time editorial staff as an Engineering Editor. His first assignments will be extensively researched articles on the technological challenges of antisubmarine warfare.

Admiral Sanders is a long-time veteran of submarine warfare. After retiring from the Navy as a Vice Admiral in 1957, he joined the Chance Vought Aircraft engineering staff where he is now Director, Antisubmarine Warfare Engineering. He is a member of the Undersea Warfare Advisory Committee of the National Security Industrial Association. This committee was organized to advise the Navy on ways in which industry's specialized know-how could be applied to assist in antisub warfare.

Admiral Sanders began his career with the comparatively primitive submarines of the 1920's, when their depth limit was 200 feet and "even there they couldn't stay down very long." Later he went on Admiral E. J. King's staff as War Plans Officer, commanded a destroyer squadron in the European theatre during World War II, and took part in the invasion of Anzio, in the Normady Invasion and in the assaults on Omaha and Utah beaches. A graduate of the U.S. Naval Academy in 1923, he later received an M.S. degree in engineering from Columbia University.

Beller has been Consultant to the House Space Committee, to Booz-Allen Applied Research, to Applied Science and to other industrial concerns. He has been on the mathematics and engineering faculties of the University of Southern California and Polytechnic Institute of Brooklyn. Early in his career Beller was graduated from the Georgia Institute of Technology and from New York University with degrees in mechanical and aeronautical engineering. He has been Managing Editor of AERO DIGEST, and Engineering Editor of American Aviation, now AIRLIFT magazine. He is co-author of *Satellite*, one of the first books written about artificial satellites.

—news briefs—

TEST SHOT STEPUP—Testing schedule of the Martin *Titan* ICBM is expected to be accelerated following a seventh successful shot March 22. Second stage separation and ignition was accomplished along with a closed-loop test of the radio inertial guidance system. A capsule containing a recording of peak heating while telemetry was blacked out during re-entry was recovered.

***BOMARC* DECISION DUE**—The Air Force is winding up a review of the controversial *Bomarc B* air defense missile amid speculation it will fight a cutback of the program. A proposal is under consideration, the AF also disclosed, to add two *Atlas* ICBM squadrons (18 missiles) to the 13 presently programed. The move costing $326 million would provide for increasing the last six *Atlas* squadrons from nine to 12 missiles.

REDS THREE YEARS AHEAD—Former Assistant Air Force Secretary Trevor Gardner estimates the Russians are still three years ahead of the United States in the space race.

NORTHROP PROFITS SLIDE—Six-month income for the period ending Jan. 31 of $110.7 million and net profits of $3.1 million were reported by Northrop Corp. This compares with sales of $122.7 million and profits of $3.3 million for the same period last year.

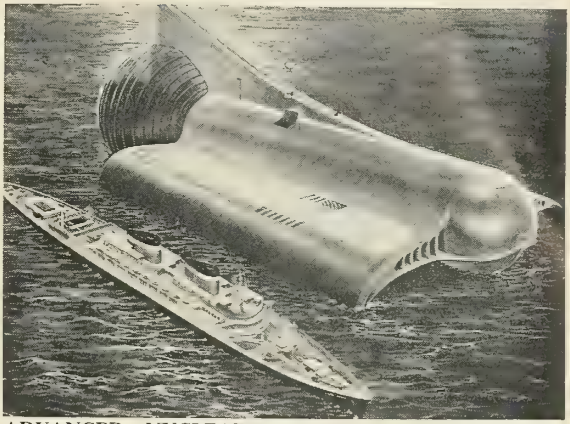
MOBILE VS. HARD—Air Force and Navy witnesses will testify March 28 before the Holifield House Military Operations Subcommittee on the relative advantages and disadvantages of mobile and fixed missile base systems.

THIOKOL NET UP 84%—Thiokol Chemical Corp. net earnings for 1959 totaled $5,521,631, or $1.22 a share—an increase of 84% over the 1958 earnings, which were $0.72 a share . . . Temco Aircraft Corp. directors decided to defer payment of a dividend and invest earnings in a growth program although, directors said, "earnings for the year 1960 are currently projected to be greater than those realized in 1959." . . . Thompson Ramo Wooldridge Inc. earnings for 1959 totaled $9,743,918, or $3.02 a share, a rise from the 1958 income of $8,979,232, which was $2.86 a share . . . Admiral Corp. 1959 earnings tripled those of 1958. Net income rose to $4,108,450, or $1.71 a share, compared with 1958 totals of $1,375,017, or $0.57 a share.

In next 20 years . . .

Fantastic Vehicles Will Be Realities

NUCLEAR SHIP of the 1970-1975 period. Could be *Antares*-type vehicle, first major application of the *Rover* type fission reactor rocket.



ADVANCED NUCLEAR spacecraft of 1980, could be the *Aldebaran*. S.S. United States illustrates the scale of this 50,000 ton vehicle.

by John F. Judge

An increasing amount of vigorous interest in the developments of the next twenty years in space is being displayed by some of the nation's largest missile manufacturers.

Long-range studies are arriving at concepts which might seem to the layman to be at home in fantasy—but are nonetheless based on hard technical knowledge.

An effort just completed at The Martin Co. anticipates developments in the coming two decades such as—

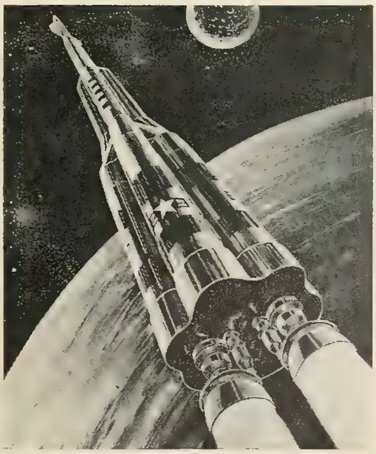
• *Antares*—a nuclear vehicle of the *Rover* propulsion type, weighing up to 20 million lbs. and capable of soft landing 4 million lbs. payload on the moon.

• *Aldebaran*—an advanced nuclear vehicle in the 50,000-ton class, rivaling the S.S. United States in size but with lunar capabilities.

This latest study is reported here as a result of MISSILES AND ROCKETS' continuing interest in the subject.

Postulating an intelligently planned and enthusiastically supported national space program—and assuming that the current effort will continue to be aggressively pushed on a broad front by industry and government, Dandridge M. Cole, Martin-Denver's senior advanced planning specialist, produced an analysis outlining the trend toward low-cost, high-performance, manned spacecraft.

In the beginning of the report, Cole examines the effect of structural improvements on the gross weight-to-payload ratio (G/L) of vehicles. The prevailing skepticism over the possibility of transporting several tons over extended reaches of space is understandable, says Cole, since all we have been able to accomplish is in the nature of the *Vanguard* and *Discoverer* shots—the average ratio involved here is about 400 to 1.



SUCCESSOR TO *Saturn* could be *Arcturus* employing two Rocketdyne F-1 engines. This is a logical replacement for *Nova* in terms of economy and development speed.

Considering lunar landings, the G/L ratio goes as high as 4000 to 1 with current propellant systems—again supporting conservatism.

But Cole points out that the expected G/L for *Vega* was only 700 and for *Saturn* is down to around 500. These reductions were due almost entirely to structural improvements.

Further, with current propellants, the G/L for a three-stage lunar landing vehicle can be lowered from 1000 to 1 down to 500 to 1 by raising the average propellant fraction (propellant weight divided by gross weight minus payload) from 0.86 to 0.89.

A 50% increase in propellant performance through high-energy chemicals would bring the G/L down to 200 for a propellant fraction of 0.76. Even greater reductions can be had through nuclear concepts such as *Rover*.

The upshot of all this is that large performance gains can be made from improvements in structural efficiency—particularly through increase in vehicle size.

• **Larger vehicles**—Cole says that the initial impetus for increasing the vehicle size and gross weight is founded in the need to place large manned payloads in orbit, and instruments on the

moon. *Saturn* will effectively meet these requirements.

Beyond *Saturn*—which is just about capable of one-way manned lunar missions—there is a need for manned round trip abilities which can be satisfied by increasing the gross weight to 2.4 million lbs. *(Arcturus)* or 4.8 million lbs. *(Nova)*. Some improvement in structural efficiency is to be expected.

The Martin scientist said that this is the area in which further increases in weight no longer result in propellant fraction improvements. This is the point at which the nuclear-propelled vehicle becomes superior to the chemical rocket. The reason is that the fixed weight items have become negligible when compared to the entire vehicle.

The large fixed weights of shielding in nuclear vehicles provide another incentive for an increase in size. The development and production costs in both systems do not increase as fast as the vehicle size, because the weight increase is in low-cost structural metals. Now the cost picture begins to change for the better in relation to the vehicle size.

In the gross weight vs. time chart, the broken line represents Cole's earlier advanced planning curve plotted during the 1955-58 period. Today this curve seems highly conservative, but Cole points out that as late as mid-1958 the idea of building vehicles of over 2 million lbs. by 1977 " . . . seemed to many to be too great a strain on the imagination."

It is interesting to note that the new curve shows the growth of U.S. vehicles may have started with the all-U.S. *Vikings* rather than with the modified and rebuilt German *V-2* rockets.

• **Specific impulse**—The relation of an increase in propulsion performance to the gross weight to payload ratio shows that three-stage vehicles with current propellant systems having vacuum specific impulse in the 300 second or lower range do not have the energy to provide efficient transportation to the moon. This changes as the I_{sp} increases to about 400 seconds.

When the I_{sp} is 600 the values of G/L reach 15 to 1, a very efficient level. The *Rover* nuclear rocket concept I_{sp} level reaches values of 800 and the staging requirement falls to just two, since little is gained with a third stage in terms of efficiency. At an I_{sp} of 1000, one stage almost equals three; in the advanced nuclear area of around 1700, the G/L drops to about 3 to 1—better than present commercial jets on a 5000-mile flight.

Current chemical propellants already have vacuum specific impulses above 300 seconds, and Cole expects that 320 seconds should be reached in the near future. Vacuum values cannot be attained in the atmosphere so an I_{sp} of 260 seconds more reasonably represents present sea level values. In anticipating the increase in specific impulse, Cole deducts the energy losses in overcoming drag and gravity and plots the average against time. Numbers taken from the curve can be inserted directly in the equation

$$\Delta V = Ig \ln \gamma$$

to give the velocity change for each stage. The value I is the adjusted specific impulse and γ is the ratio of gross weight to empty weight.

The Martin expert estimates that by 1965, large high-energy chemical upper-stage engines powered by LOX and liquid hydrogen will be in general use. Vacuum I_{sp} will then range above 400 seconds. He further anticipates the use of the atmosphere in stepping up performance. Initially this will take the former of afterburners and other methods of adding air to the rocket exhaust.

Even these early methods of incorporating the atmosphere into the propulsion system would have effective specific impulse values well over 500 and as high as 600 seconds. This means the average I_{sp} for all stages should exceed 450 seconds.

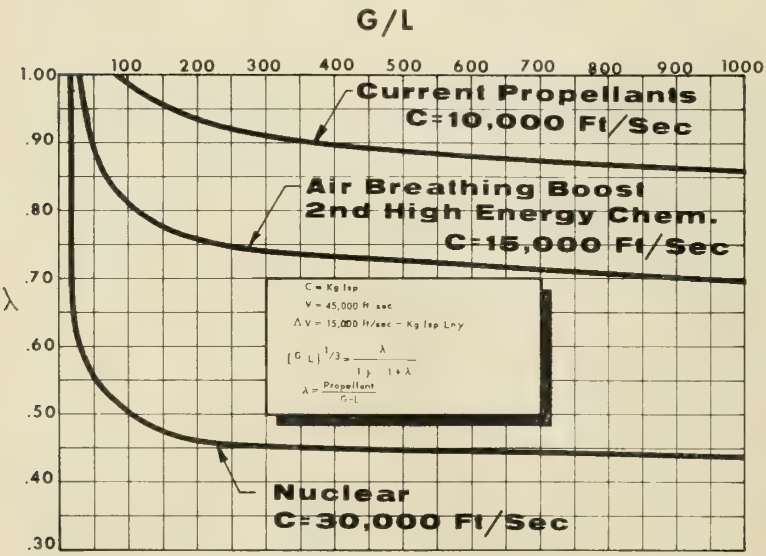
Cole finds substantial agreement among propulsion experts that the early nuclear rockets should be in use by 1970. These engines will have I_{sp} ranges from 700 to 900 seconds and will probably find extensive use in upper stages. By this time air-breathing first-stage systems should be in the neighborhood of 900 seconds, providing an overall vehicle average of about 800 seconds.

When the flight performance gains outlined in the first section of the study are combined into advanced vehicles, the capabilities are startling. Cole chose the amount of payload soft-landed on the moon as the performance parameter in considering the total effects of the improvements.

• **Underestimation?**—In this respect the Martin scientist notes a lack of appreciation of the lunar payload capabilities which can reasonably be expected of the 1970-1980 period.

Two tendencies contribute heavily to this indifference. The first is the habit of considering each improvement individually instead of combining them and the second is the general, unrealistic conservatism and excessive caution hindering extrapolation beyond current accomplishments.

In his analysis, Cole begins by considering the *Vega, Centaur* and *Saturn* vehicles. Although the *Vega* was cancelled, it represents the payload capability attainable with an *Atlas* or *Titan* with essentially no modification except the addition of an upper stage. The original *Vega,* an *Atlas* plus a *Vanguard* first stage, could softly land 500 lbs. on the moon. If the upper stages added to either *Atlas* or *Titan* used high-energy chemical propulsion systems, this payload could increase to 1000 lbs. The particular high-energy upper stage planned for the *Atlas* in the early 60's involves a LOX and liquid hydrogen system and is desig-



THREE STAGE LUNAR LANDING VEHICLE

EFFECT of improvements in structural efficiency of three-stage lunar landing vehicle.

MOLECULAR ELECTRONICS THE THIRD MAJOR BREAKTHROUGH in the history of electronics...

as significant today as the vacuum tube in 1907... as the transistor in 1948.

Molecular electronics use new insights into the structure of matter to create single crystals which perform one or more complete electronic functions in the control and transformation of energy.

Westinghouse can now report startling progress in this fantastic field—in this status report on a U. S. Air Force research program which began less than a year ago.

Fact one: molecular electronic systems are here today—in laboratory models which prove out the principle even as they pave the way for production models. On the next two pages are a number of different molecular electronic devices performing the functions of familiar systems, without conventional components.

Fact two: each one incorporates germanium or silicon crystals—etched, sprayed or alloyed.

Fact three: each one is a functional block which performs the missions usually requiring conventional components soldered together.

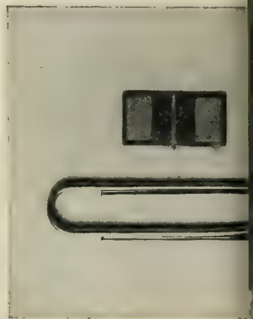
Prediction: soon, multi-zoned crystals will be "grown" and processed directly from the furnace melt—may emerge as ready-made electronic systems.

Prediction: only two to five years from now, the pattern of electronic systems will be changed to the core as a result of this historic Westinghouse breakthrough in research and development. Reliability, miniaturization and simplicity will show exponential progress.

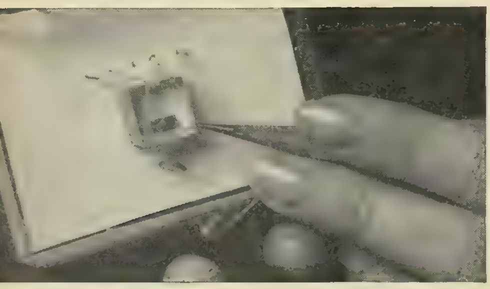
Westinghouse presents working proof of the principle of molecular electronics

POWER AMPLIFIER: Button-sized molecular electronic device held by girl with a pair of tweezers performs the same amplifying function as a conventional 5-watt amplifier, has a frequency range from zero to 20,000 cycles. Working element is a block about as large as the head of a pin.

VIDEO AMPLIFIER: made with a tiny wafer from a ribbon of germanium crystal. This function block also works like a radar amplifier sub-system. Gain is essentially flat to frequencies of several megacycles.



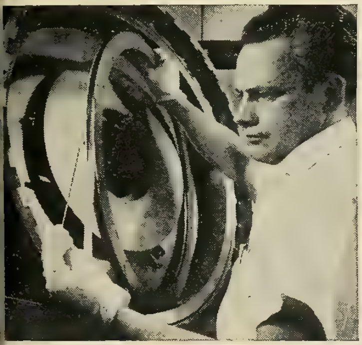
MULTIVIBRATORS: stable, monostable, astable—covering quencies from 1 cyc less to 3 megacy Shown is a free run multivibrator along paper clip.

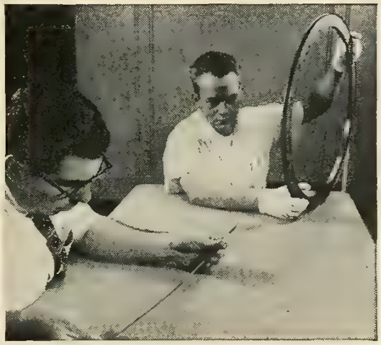


MULTI-POSITION SWITCHES: these molecular electronic devices evolved out of Westinghouse work on multivibrators—the "OR" logic switch illustrated has important potential applications in missile countdown functions.

LIGHT TELEMETRY SUB-SYSTEM: a single light-responsive monolithic element delivers output whose frequency is a measure of light intensity.

-C AMPLIFIER: connected to a solar cell, this tiny block takes an in-
ut of 4 milliamps . . . via flashlight beam, raises it to 40-watt output.





RYSTAL GROWING techniques developed by Westinghouse have already roduced germanium dendrites 300 feet long in the special furnace shown left, above. Crystal ribbons of almost any length are possible. The take- reel at right holds 300 feet of the brittle dendrite with each turn cushioned n glass-cloth tape.

CRYSTAL RIBBON requires no grinding or lapping. Only a few steps are needed to turn these "educated" crystals into working electronic systems. Above, multiple-junction systems are shown on a crystal section.

The meaning of molecular electronics

RELIABILITY: molecular systems reduce drastically the number of components and internal connections required—and the fewer components and connections the fewer potential trouble spots.

MINIATURIZATION: molecular electronic systems are less than one-thousandth the volume and weight of conventional component systems. This is a conservative generalization—in many cases, much more startling size and weight reductions are possible.

POWER REQUIREMENTS: input power can drop almost as fantastically as size and weight. In a typical light telemetering sub-system, a 5-watt input is required; the transistorized version gets by with 0.75 watts. The same function is still performed by a molecular electronic block requiring but 0.06 watts.

ENVIRONMENT: inherently more resistant to g-loads because of their small mass and few components, Westinghouse-developed molecular systems show promise to be temperature and radiation resistant as well. New semiconductor materials and new large crystal surfaces point to very high temperature and power-handling capabilities.

FUTURE: progress in this new field is so rapid, and the advantages so great, that the molecular electronics concept will find wide applications in air/space electronic systems within 3-5 years . . . In particular, look for great advances in the state of the art in these areas: telemetering • fire control guidance • communications • counter weapons • flight control—as a direct result of the new molecular electronics era.

The Air Arm Division of Westinghouse Electric Corporation holds the U. S. Air Force management contract for this project. It is being supported by the Semiconductor Department, the Materials Engineering Department, and the Westinghouse Research Laboratories.

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nated *Centaur*.

Cole refers to *Saturn* as the first big step in size and performance beyond the *Atlas-Titan* era. Weighing about 1 million lbs. this vehicle's first-stage engine will be static-tested in the next few months. The propulsion unit is a cluster of eight engines of a type already used in the *Atlas, Thor* and *Jupiter*. This is the vehicle which just reaches the area of manned lunar flight. *Saturn* may be able to place man on the moon, but some refueling concept is necessary if he is to return.

This is the point at which Cole says the importance of the moon in the exploration and exploitation of the solar system becomes more clearly established. Along with this will come recognition and general acceptance of the value of early large-scale manned lunar flights and basing.

The *Saturn* will see maximum use in this respect; Cole anticipates increased emphasis on the early application of the F-1 engine for this purpose. The 1.5-million-lb.-thrust F-1 is under development at Rocketdyne and an early experimental model has been successfully tested.

A great deal of preliminary study has been done on *Nova*, the vehicle to be powered by a cluster of four F-1 engines generating 6 million lbs. of thrust. *Nova* has been advertised as the first vehicle capable of roundtrip manned lunar flights without refueling. Its operational date has been estimated as approximately 1967.

Some thought has also been given to a vehicle powered by one F-1 engine.

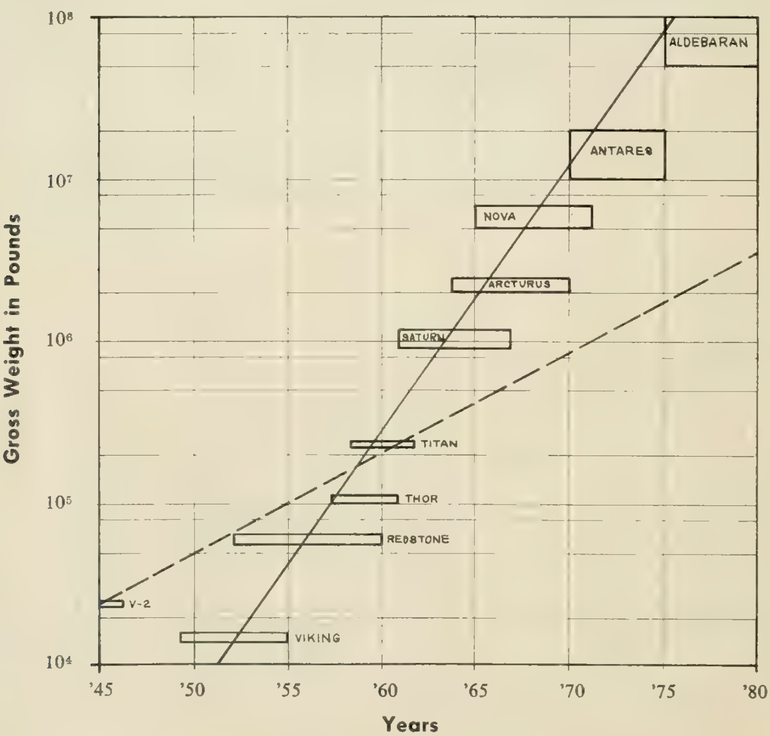
Cole says that the use of two F-1 engines in a second or third generation *Saturn* "may turn out to be a more practical compromise than either one or four engines."

Three reasons are given to support this contention.

• A single F-1 engine vehicle would have only marginal performance advantages over *Saturn*. It is doubtful that significant benefit over an improved *Saturn* could be shown in an equivalent time period.

• The *Arcturus*, with two F-1 engines as the booster, could have sufficient performance to accomplish the advertised *Nova* lunar mission at an earlier time (1964 or 1965) and involve fewer development, transportation and handling problems—at lower cost.

Increase in rocket vehicle gross weight



• *Nova* would face serious competition in the 1966-1970 period from the theoretically superior air-breathing boosters. Cole questions whether *Nova* would ever reach operational status faced with the probable performance, operational and cost advantages in air breathers.

The *Arcturus*, as outlined by Cole, would have two F-1 engines and seven *Titan* first-stage tank assemblies as a booster. The second stage might have three *Titan* booster tanks with an engine of about 500,000 lb. thrust and a single *Titan* first-stage tank.

This vehicle would have more than twice the payload capability of *Saturn* and slightly less than that of *Nova*. This is sufficient to carry several men one way to the moon or one man on a round trip without refueling.

An air-breathing booster could be developed as an improvement over the high energy chemical *Arcturus II* and as an alternate to *Nova II*. It would be possible to build a turbo-ramjet-powered booster weighing 1.2 million lbs. which would accelerate the *Arcturus II* to 4000 feet per second. This vehicle would weigh 3.6 million pounds as compared with the non-ramjet *Arcturus* at 2.4 million lbs. and *Nova* at 4.0 million lbs., and be capable of soft-landing 60,000 lbs. on the moon or 360,000 lbs. minimum earth orbit.

• **Projected vehicles**—In the nuclear era of the early 1970's, Cole envisions a conceptual vehicle christened *Antares*. This is the first major application of a *Rover* type fission reactor rocket system with an I_{sp} around 1000 seconds.

The initial boost of *Antares* is assumed to be provided by a captive acceleration system—turbojet-powered sled. The vehicle would reach a velocity of 2000 feet per second through a one g acceleration along an inclined 15-mile track. Then ramjet engines take over, bringing the speed up to about 10,000 feet per second, where the nuclear engines would kick in and take the vehicle to minimum earth orbit with an additional velocity change of 16,000 feet per second.

Cole expects these vehicle sizes to range from 10 to 20 million lbs. gross weight. Assuming this, the minimum earth orbit payload range would be from 2.5 to 5 million lbs. The *Antares* configuration (wings) would permit its safe return after an orbit trip.

Beyond orbiting missions some refueling may be desirable. In this event, 2 to 4 million lbs. could be achieved in a lunar landing payload. If there is no refueling, then upper

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stages would be necessary—with some loss in payload capacity.

If the upper stage was nuclear-powered and winged, a lunar payload of about 800,000 to 1.6 million lbs. would be possible. With two high-energy chemical stages, a further reduction of the 600,000 to 1.2 million lbs. would result.

• **Aldebaran**—The conceptual vehicle of the 1975-1980 period is the *Aldebaran,* an advanced nuclear-propelled ship. The powerplant would represent a step beyond the *Rover*—controlled fusion, gaseous core fission or nuclear pulse. The vehicle will be in the 50,000 ton class, winged and have an I_{sp} of 1500 to 3000 seconds.

The anticipated size is a result of the design efficiency or operational limitations of the propulsion system —and the fact that operational economy increases with size. Cole's logarithmic growth curve extrapolations indicate ships of this magnitude for the 1980's.

With an I_{sp} of 3000 and a propellant fraction of 0.7, *Aldebaran* could haul 60 million lbs. to minimum earth orbit or 45 million lbs. to the moon. Because of its size, water takeoff and landing would be necessary.

For earlier versions of the *Aldebaran,* Cole assumes an I_{sp} of 1500 and a propellant fraction of 0.50. Orbital payloads of 20 million lbs. would be possible, but staging would be involved in deep space missions unless a refueling concept was employed. Utilizing a *Rover* type upper stage, larger than that of the *Antares,* 7 million lbs. could be deposited on the moon.

• **Pound-dollars**—The most fundamental question involved in all of this is cost. Right now our payload effort price tags run from \$100,000 to \$1-million per pound.

But Cole says there are signs of great cost reductions as payload capabilities increase.

An examination of Project *Mercury,* assuming the announced \$350 million as the total four-year expenditure and considering the cost of ten orbital missions of 3500 lbs. each, the price per pound in orbit is \$10,000. Further, if all of the twenty capsules now on order are to be used, the cost per pound drops by 50%.

In 1965 *Saturn* orbital pound figures would be about \$200 and lunar payloads in the neighborhood of \$2000 per pound. The advent of nuclear power in the early 1970's would bring lunar payload costs down to less than \$100 per pound and, as 1980 approaches, a further reduction to less than \$10.00 per pound.

Cole attributes cost reductions to increased performance, larger vehicle size, recovery and re-use of vehicles and the fact that the vehicle size increases faster than the expense per pound.

In making these extrapolations, Cole concludes that the evolution will occur at the predicted rates based on technical considerations alone. Greater emphasis on a space program now would result in even earlier achievements of the stated goals. Cole expects that the increases in space vehicle performance and reduction in transportation costs will be sufficient to permit the establishment of large bases of colonies throughout the inner solar system.

Industry Sets Its Own Parts Standards

Manufacturers are writing their own specifications to cover deficiencies in MIL requirements; synchro reliabilities upped 700%

by Charles D. LaFond

The battle for improved system reliability in electronics is slowly being won, but it's an uphill fight all the way just to obtain reliable parts and qualified vendors.

It has been said that the only real answer to the problem lies with the ultra "simplified" systems of the future which will employ solid-state or molecular-engineered functional units. A few subsystems based on such concepts already have been made, but for the next few years their use will be limited by our lack of know-how. Snowballing research efforts by many companies eventually will provide the answers.

But we must have the very best systems obtainable now and tomorrow with today's components, materials and processes. Extensive reliability programs being carried out by many in industry embrace all recognized approaches to the problem. Rigid quality control, reliability-proven circuit design, redundancy—these and other parallel approaches are yielding better system performance.

A major tool in all of these methods is the policy of rigid parts selection—a kind of "weakest-link" approach to critical components.

Wherever reliability is a major goal, leading manufacturers are using parts that exceed military specifications, often by several orders of magnitude. To do this, manufacturers are writing their own rigid specifications, carefully selecting and monitoring vendors, and continuously testing and retesting for further parts improvement.

The task is painstaking, tedious, expensive—but it is achieving results.

• **QPL & MIL spec. deficiencies**—Why have manufacturers written their own rigid parts specs? Here are the criticisms of one major producer—Motorola's Western Military Electronics Center:

• "We know that there are no two products from different vendors that are exactly alike. Yet the QPL (Qualified Products List) treats a large number of qualified vendors as equals. We need to be more selective. Tests to failure and multi-level stress tests help us be selective.

• "The MIL specification requirements are written for rather broad, general applications, whereas we usually are concerned with more specific applications. MIL requirements are not stringent enough and have merely succeeded in establishing a low level above which a great many vendors can keep their product.

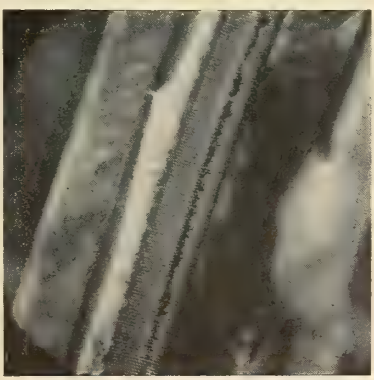
• "Most MIL specifications trust the qualification test to prove quality, whereas it may be representative only of the vendor's best, carefully planned effort. Most MIL specifications have inadequate provisions for follow-up tests to monitor the quality.

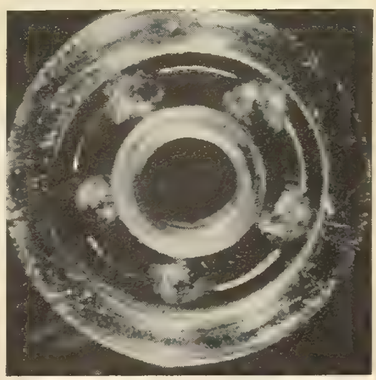
• "Quantities tested during qualification are too small.

• "Time delay in issuing MIL specifications is so great that they do not keep up with the newest developments in products or in requirements. (For example, dipped mica capacitors are still not standardized, and many specifications still call out only 55 cps vibration.)"

• **What's being done?**—Both Motorola and AC Spark Plug Division of General Motors Corp. (and of course many others) employ programs of extended performance testing under varied and severe environments to select reliable parts.

To obtain good parts (and vendors),





TYPICAL FAILURES which occurred on electrical or associated parts during rigid testing by AC Spark. Left: resistance wire of precision potentiometer exhibits varnish from resistance-wire mandrel cradle causing intermittent open circuit and high noise. Right: servo-motor miniature precision bearing shows deteriorated lubricant causing high-friction motor torque.

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MEET SOME OF THE AIRCRAFT/MISSILE/SPACE SPECIALISTS BACKING UP THE WESTINGHOUSE SALES ENGINEER:

A. M. Bruning, Engineer-In-Charge, Advanced Development Group
Age: 33
B.E., Johns Hopkins, 1949
M.S., Mathematics, University of Pittsburgh, 1956
Specialties: Arc Heated Aerodynamic and Thermodynamic Test Facilities, MHD Research Facilities
Years with Westinghouse: 8

W. J. Walker, Engineer-In-Charge, Aviation Facilities Group
Age: 42
B.S.M.E., University of Southern California, 1949
Specialties: Wind Tunnels, Sonic Fatigue Test Facilities, Hardened Base Equipment, Launchers
Years with Westinghouse: 11

R. A. Feranchak
Age: 29
B.S.E.E., Youngstown College, 1952
Specialties: Arc Heated Aerodynamic and Thermodynamic Test Facilities, Explosive Forming, Rotating Equipment Test Stands
Years with Westinghouse: 7

R. F. Leepa
Age: 29
B.S.E.E., Lafayette College, 1953
Specialties: Military Power Plants, Radar Antenna Drives
Years with Westinghouse: 6

P. J. Hawkshaw
Age: 36
B.S.E.E., Catholic University, 1950
Specialties: Continuous-Flow and Hot Shot Wind Tunnels, Explosive Forming
Years with Westinghouse: 9

J. McDonald
Age: 43
A.B., Chemistry, Engineering, Physics, University of California, 1938
Specialties: Arc Chamber and MHD Generator Development
Years with Westinghouse: 13

H. C. Lee
Age: 40
B.S.E.E., Chiao Tung University (Shanghai), 1942
M.S., Engineering, Cornell University, 1949
Ph.D., Cornell University, 1951
Specialties: Arc Chamber and MHD Generator Development
Years with Westinghouse: 2

H. A. Zollinger
Age: 30
B.S.E.E., Michigan College of Mining and Technology, 1951
M.S.E.E., University of Pittsburgh, 1958
Specialties: Drive Systems for Loaders, Elevators, Erectors and Launchers
Years with Westinghouse: 9

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tests made tougher . . .

AC Spark conducts selected tests on small samples of *each lot* of critical electrical and electronic parts. It feels its approach provides a rapid and economical method of testing.

It is a two-part program. Initially, extensive qualification tests are performed to determine parts capability and adequacy. Through performance and environmental tests, including the determination of destructive test limits and tests to evaluate life characteristics, a few qualified suppliers are found.

From then on, continuous surveillance is maintained to assure that the vendor's processes and manufacturing techniques do not deteriorate. This is accomplished by the extended performance testing on samples (10%) and by a 100% inspection of all parts to increase principal performance characteristics.

Whenever justified, requalification tests are initiated.

The criticalness of an item to the reliability of a particular system is judged largely by four factors:

- Environmental stresses.
- Total parts (of one kind) used.
- Expected or known part failure rate compared to the apportioned failure rate.
- Suppliers' ability to provide a stable product.

The results of such a test program have been very gratifying, according to AC Spark, in reducing the number of potential part failures in equipment.

Items shown in the accompanying table are a few of the critical parts in a ballistic missile guidance system. The last column indicates the increase in reliability achieved between early 1958 and December, 1959. Although other figures are not available, a 400% increase in reliability also was obtained for relays. Relays were tested from 34,000 to 136,000 operations.

- **Causes of failure**—While the program progresses, failure causes are determined and a solution is then worked out with the cooperation of the supplier. In general, the program results indicated a lack of control by parts manufacturers of their processes, manufacturing procedures, and quality control practices. Lack of adequate control was indicated in:

- Material inspection—improper or incomplete.
- Processing procedures—either not followed or lack of definition required to insure product consistency.
- Workmanship—poor and lack of inspection of critical workmanship items.
- Cleanliness—poor.
- Design changes—improperly researched or non-notification to user.
- Final inspection—inadequate.

- **Company specs**—When adequate —or required—strict MIL parts are procured to MIL documents; but the problem most firms face today is the urgent need for better-than-MIL parts.

Motorola engineers told M/R that they know many parts are better than the MIL reliability level from the results of its testing program. For these, the company has prepared its own specs, not making burdensome requirements but written around these quality items which are standard products of the vendor.

These specs follow the MIL format, but have more rugged tests and test sequences, require more specimens, allow fewer failures, tighten electrical requirements, and have provisions for periodic reassurance tests—including penalty clauses for failure.

Motorola has altered test sequences in the specs to represent the most rugged treatment sequence the parts could encounter. For example, for encapsulated parts it precedes humidity tests with lead-bend and thermal-shock tests so that moisture will enter if cracking occurs.

For environmental testing, MIL-STD-202A is used liberally; though it is not perfect, it at least represents a much used standard. However, the company feels increasingly perturbed by non-reproducibility of the "Moisture Resistance Test" (Method 106) when performed in different high-quality chambers. It uses steady-state, long-term humidity tests (over aqueous glycerin solutions of known refractive index; ASTM) for some of its screening tests. Also the vibration requirements of all of its specifications have been upgraded to include 2000 cps shake.

To provide an adequate number of specimens, the typical MIL quantity of 12 is upped to 20 or more and usually 30 to 50 for inexpensive parts.

Where screening tests show that a part can endure electrical stresses much in excess of ratings, Motorola attempts to persuade the vendor to agree to tests at these higher stresses. This is done not so much to accelerate the tests by a known amount, and thereby obtain a better approximation of the mean-time-to-failure, as to increase the general safety factor.

Allowable drifts and changes in value have been reduced and requirements for insulating properties have been increased. This results in a greater selectivity within the known better vendors.

The concensus is that in maintaining a rigid program for parts reliability the capabilities of the parts selected for use can be thoroughly understood. From this knowledge, adequate allowances for parts limitations can be made in the design of more reliable circuits.

PART TYPE	NO. LOTS TESTED	NO. LOTS REJECTED	% REJECTED	% INCREASE RELIABILITY
Resistor, Fixed Film	465	23	5	70
Resistors, Fixed Wirewound Power and Accurate	163	11	7	300
Capacitors, Paper	185	32	17	350
Motor-Tachometer-Generators	24	6	25	93
Synchros	22	7	32	730
Electron Tubes (miniature)	44	4	9	200
Diodes, all types;	36	16	44	120
Zener	—	—	—	300

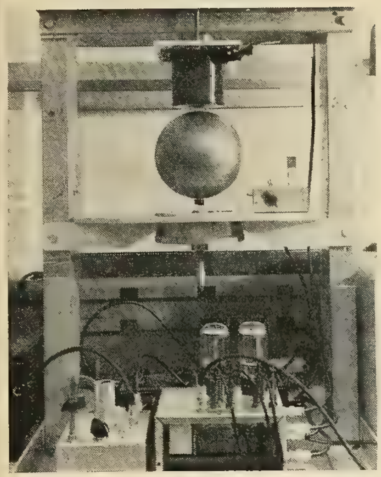
SOME results of AC Spark Plug Div. critical parts test program over two-year period. (Numerical failure rates are not given since relation to environments, missile locations and firing information, and number of systems are not provided.

'Space Compass' Will Tell Astronaut Where He Is

(cover photo story)

A unique "space compass" will help Project *Mercury* astronauts return safely to earth in case of emergency. Called an Earth Path Indicator, the Honeywell-developed device will show the astronaut his position over the earth at all times. In case of failure of earth command control circuits, the EPI will indicate the precise point in the orbit for firing the retrorockets to land in the proper impact area.

The device contains a replica of the world revolving in a composite motion



ATTITUDE OF spacecraft can be controlled by electrically torquing a sphere-mass freely suspended in an electrical field, according to Systems Division of Bendix Corporation (M/R, p. 34, March 21). Shown is a working model of one such suspended sphere where the three mutually perpendicular torquing coils have not yet been mounted.

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corresponding to the earth's rotation and the capsule's orbit track. A bulls-eye window pinpoints the capsule's instantaneous location over the earth. Other markings indicate capsule landing points.

In normal operation, the EPI will be started by the astronaut during the prelaunch countdown. After going into orbit, corrections will be manually cranked in to correspond to orbit determinations radioed from earth.

In case of communications failure, the device will operate on the basis of the planned orbit. The astronaut will be able to make corrections based on visual observation of the earth through the capsule's periscope.

Once set on the proper orbit track, the EPI will automatically continue its motion to follow this track. The astronaut will be able to visually follow his position and initiate orbit ejection at the proper point if this becomes necessary. Ordinarily, the ejection will be triggered by command from the ground. Only in case of circuit failure will it be necessary for the astronaut to initiate the action himself.

The device, though small, is quite complex. The requirement for the combination of two different motions—earth rotation and variable orbit track—made its design difficult. In addition, a high order of accuracy was vital. Impact on land might be disastrous; impact outside the designated Atlantic

area would complicate and delay recovery operations.

The EPI has four adjustments which the astronaut can control: position, inclination, period, and earth rotation. It is powered by a spring mechanism to make it independent of capsule electrical power.

Markings on the globe show longitude, latitude, continents, topography, and major cities. It is made of a hollow aluminum sphere covered with a map silkscreened on plastic.

Development of the Indicator grew out of human factor studies by Honeywell for McDonnell Aircraft, prime contractor to NASA for the capsule.

Telemetering Conference To Present 71 Papers

The 1960 National Telemetering Conference at Santa Monica, Calif., is shaping up as the biggest and most ambitious in NTC history, according to Hugh Pruss, conference chairman. The three-day meeting (May 23-25) will present 71 technical papers in 16 panel sessions. Two workshop sessions are also scheduled.

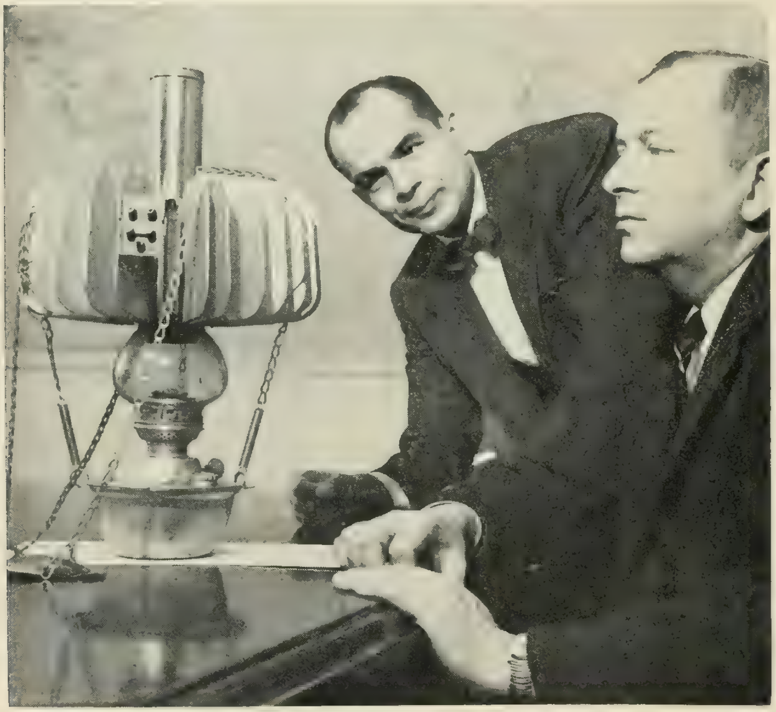
Theme of the conference is "Telemetry—Tool for Industry and Defense." Although most of the papers will deal with military problems and applications, the industry viewpoint will be represented in about half the sessions. This marks a definite departure from previous conferences which were devoted almost entirely to military aspects.

Sponsors this year include the Institute of Radio Engineers, which recently rejoined the NTC. (Other sponsors: American Rocket Society, Instrument Society of America, American Institute of Electrical Engineers, and Institute of Aeronautical Sciences.) Participation by the IRE in this conference will also have an effect on its heretofore competitive Telemetering Symposium—sponsored by IRE Professional Group on Space Electronics and Telemetry. This year's meeting (Washington, D.C., Sept. 19-21) will concentrate on space electronics and devote only one session to telemetry.

The preliminary program lists these session topics:

- Industrial data transmission systems
- Biomedical measurements
- Space data-acquisition systems
- General r-f components and techniques
- Missiles and aircraft telemetry workshop (R&D needed in the '60s)
- Data processing and presentation—(two sessions)
- PCM progress
- Transducers
- Ground stations—new components and techniques
- Industrial supervisory control
- Missiles and aircraft—flight data systems
- Telemetry techniques—(two sessions)
- Missiles and aircraft—environment measurement
- Transistorization progress
- Industrial telemetry workshop (What we really need is . . .)
- Reliability in telemetry

Studying Soviet Converter



RUSSIAN-BUILT thermoelectric generator, used to convert heat from a kerosene lamp into electricity for radios is studied by energy conversion group scientists of Martin-Nuclear. The export model of the 20-pound Russian device was bought in England for $56. Group was set up recently to press research in thermoelectricity and other means of converting heat directly into electricity without the use of moving parts. Eventually, such methods will be used in connection with nuclear reactors.

NBS 'Atomic Clock' Considered Most Accurate

A new cesium standard "atomic clock"—with an accuracy of better than one second in 1000 years—has been developed at the Boulder Laboratories of the National Bureau of Standards.

Believed to be the most accurate such instrument in the world, the new frequency standard is 10 times more accurate than any previous NBS atomic clock. It will be used to maintain the accuracy of radio time and frequency standards and calibrate other ultraprecise instruments.

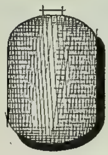
The clock can also be used in experiments to verify concepts of Einstein's theories of relativity. Current NASA plans include placing an atomic clock in an orbiting satellite and comparing its time with a clock on earth. According to Einstein, the two will run at different rates depending on the satellite's speed and distance from the earth.

Such precise measurements of time and frequency have become increasingly important during the past few years. The missile/space program particularly has made demands for orders of accuracies not even considered a few years ago. As an example, to accurately plot the position of a long-range missile, time at tracking stations must be coordinated to within millionths of a second.

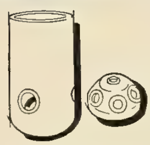
Until recently, the most precise frequency standards have been provided by the vibration of quartz discs in electronic oscillators. These are almost as accurate as atomic standards for short periods. Quartz tends to age, however, and over longer periods of time its vibration rate may change unpredictably.

Garlock's main objective

in missiles work...



Filament wound rocket motor cases made by exclusive Garlock method result in structure much lighter and stronger than steel.



Insulation for solid fuel rocket motors made by Garlock is rubber-like compound which encounters gas velocities of Mach 3-5, temperatures to 5500° F., prolonged ambient temperatures of 300° F.

Missile parts from inert materials including newly developed asbestos-phenolic compound for nozzles . . . nose cones of fluorocarbon plastics.

Garlock metal fittings for rocket motor cases such as blast tube and thrust terminator support rings are machined to extremely close tolerances. Made from special materials affording minimum weight, maximum strength and rigidity.

is delivery of high quality rocket motor components in the shortest time. To reach this common goal, research and development, product design, tool design, pilot manufacturing, and production staffs work together as a fully integrated team. They solve problems of design and production jointly, thus eliminating weeks of possible re-designing and re-tooling.

Garlock is flexible: they'll swing into prototype production on short notice and follow this with full scale production as needed. *Garlock is diversified:* they'll design and manufacture rocket motor components from a variety of basic materials—rubber, metals, phenolics, fluorocarbon plastics.

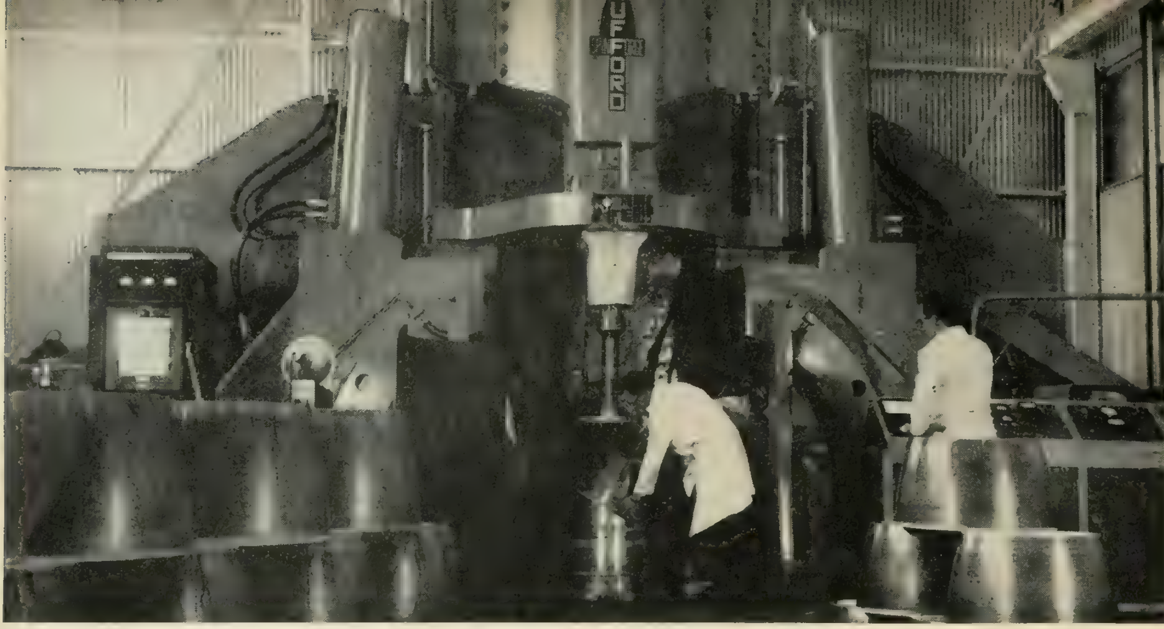
Garlock engineers will work to your design or help you in developing designs. Call or write Military Products Department, The Garlock Packing Company, Palmyra, N. Y.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Garlock components are presently used in the development and production of:

• Vanguard • Super Vanguard • Polaris • Minuteman • Nike Hercules • Terrier • Super Tartar



SPIN-FORGE cold-flows preformed metal blanks into parabolic shape for *Bomarc* engine lip skin.

propulsion engineering

Marquardt's *Bomarc* Ramjet Production

EXPLOSIVE FORMING technique, used to form unusual configurations from preformed welded tubes, speeds production.

About 670 components go into the *Bomarc* kerosene ramjet sustainer engine, manufactured by the Marquardt Corp. at its Ogden, Utah, division.

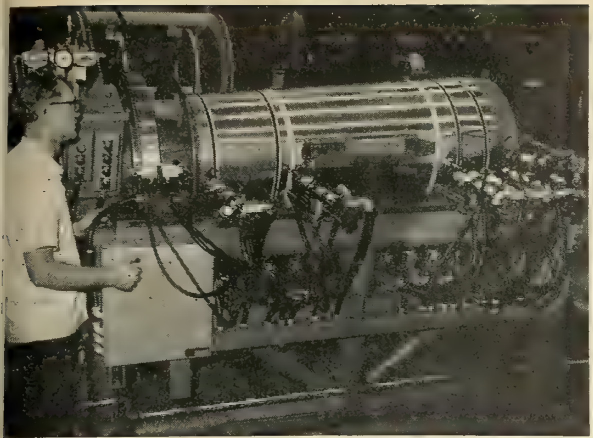
The engine, designated RJ43, breathes air and produces a compression ratio of 100:1 to maintain a velocity of 2600 mph. In comparison, a high-compression automobile engine operating on high-octane gasoline delivers a compression ratio of 10:1.

Manufacture of the 500-lb., 14-ft.-long engine is shown for the first time in the accompanying pictures.

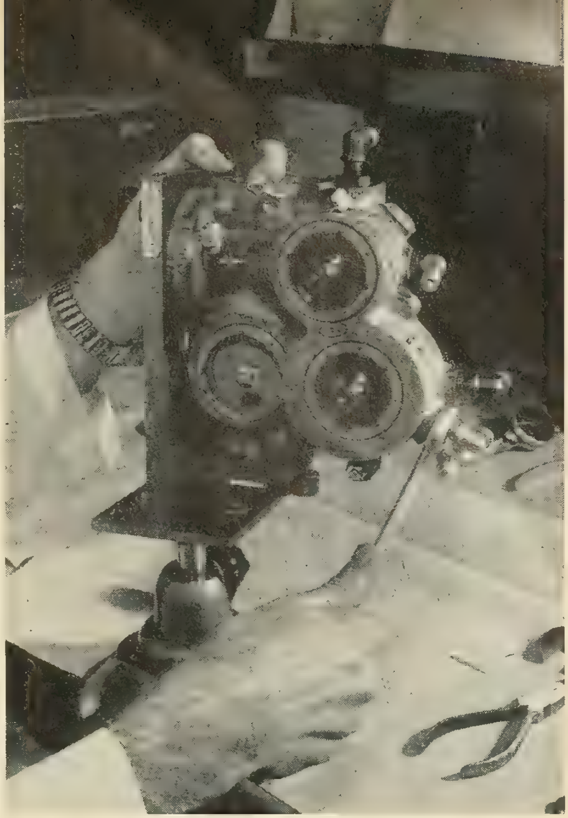
Bomarc, a 400-mile-range antiaircraft defense weapon, is designed to attack enemy bomber formations before they reach target areas. It is launched by a rocket booster. The currently operational *Bomarc A* uses an Aerojet-General liquid-propelled booster. The advanced *Bomarc-B,* in development, uses a Thiokol solid booster.

Twenty basic production techniques in metal fabrication and processing, heat-treating, machining, test and inspection are used in preparation of the components. The structural section develops through 17 assembly stations. Fuel control and other internal systems are put together in a hospital-clean precision assembly department.

Of the 670 components, 607 are manufactured at the Ogden plant. A new explosive forming technique is used in making high-strength tubular sections. After the completed engine leaves the assembly line, it undergoes flight test, post-burn systems check and is canned in a special inert-gas-filled container.

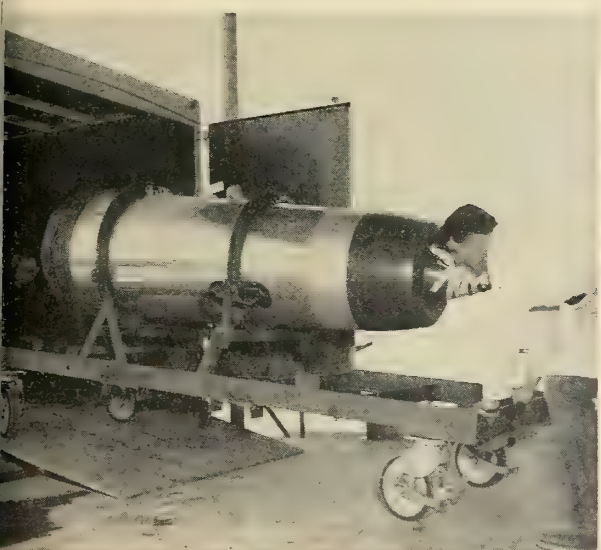


SPECIAL JIG holds outer skin over main structure as six automatic drills bore and counter sink riveting holes.

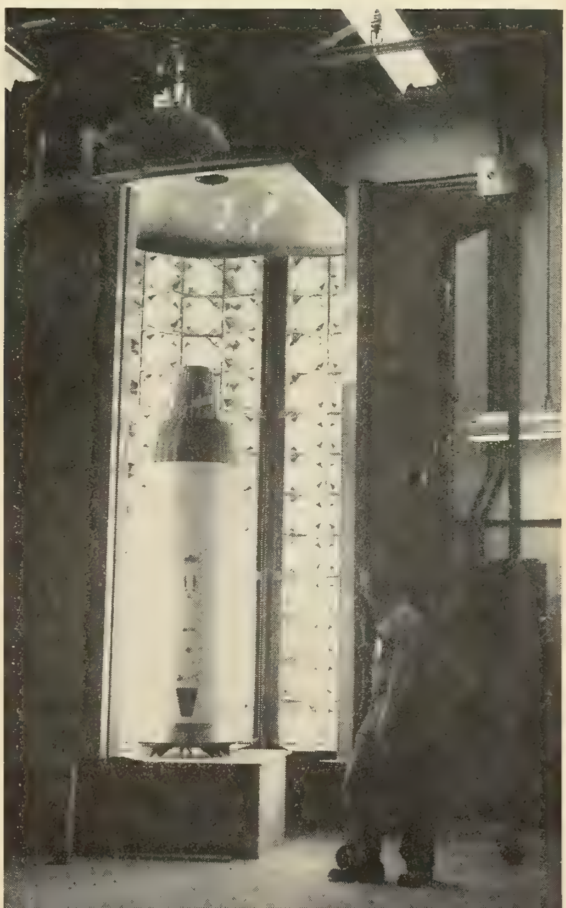


FUEL CONTROL is bolted to a jig in preparation for connecting fuel and air lines of the system.

Detailed



FINISHED ENGINE is loaded in van for 15-mile trip to test area with protective cover on end section.



HEAT-RESISTANT, high-finish paint is baked on the missile in this specially designed oven.

Aerojet Motor May Bring Big Booster

by Jay Holmes

Aerojet-General Corp. has successfully fired an experimental segmented solid-propellant motor that could be a forerunner for the Air Force's big Project 3059 booster.

The experimental motor generated almost 40,000 lbs. of thrust for 10 seconds, Aerojet said.

Meanwhile, it was learned in Washington that the Air Force and Aerojet were close to signing a contract last week on Project 3059—which calls for developing a new generation of solid-propelled rockets, several times larger than the *Minuteman* booster, the largest solid rocket now under development in this country.

Project 3059 calls for a rocket of about 100 million lbs. total impulse. Neither thrust nor burning time was specified. Thus the rocket could be 1 million lbs. thrust for 100 seconds, 2 million lbs. for 50 seconds or any combination with a 100-million product.

• **Second go-around**—This is the second time around for the big booster proposal. It was circulated in the spring of 1959 as a plan for a booster with a million lbs. thrust. However, Air Force officials at the highest level turned it down last summer on the grounds that it sounded more like a public relations gimmick than a serious proposal for rocket development.

Since last summer, the specifications were rewritten to give the contractor more leeway. The current idea is that instead of developing something to do a particular job the contractor will concentrate on advancing the state of solid-propellant technology.

Six companies bid on Project 3059. Besides Aerojet, they were Thiokol, Rocketdyne, Grand Central, United Technology Corp. and Hercules Powder Co. The bidders took two approaches toward solving the physical problems involved in building a large booster.

Aerojet, United and Grand Central based their proposals on segmented design, so that the parts could be transported by normal means from the manufacturing plant to the launch site. Thiokol and Rocketdyne proposed on-site manufacture and loading of propellant. It could not be learned which

approach Hercules favored.

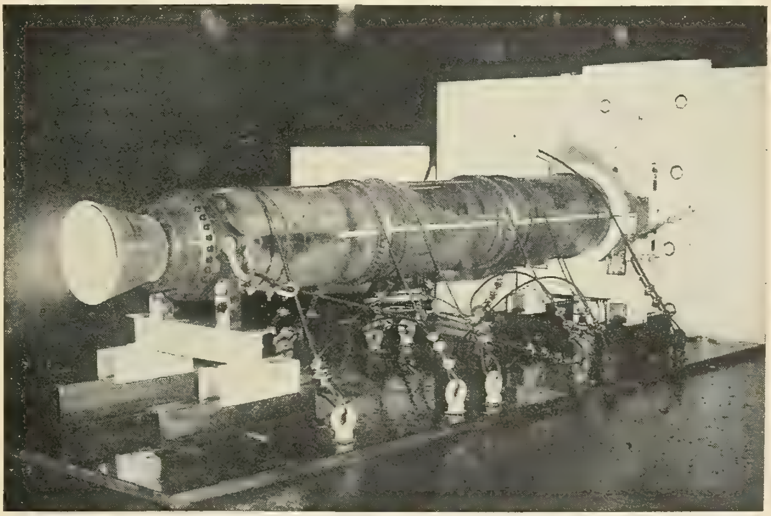
• **New flexibility**—Aerojet said its segmented rocket was static fired last July at its Sacramento test facilities. Dr. Ernest R. Roberts, Aerojet manager of solid rocket research and development, said the test was 100% successful.

Segmented rockets would give this nation its first truly flexible rocket program, Aerojet said. The blocks can be constructed with current technical know-how in present facilities, the company added. They would be shipped to the launch area over conventional roads, on conventional railroad cars and through conventional tunnels and underpasses, thus eliminating logistical problems.

The General Tire and Rubber Co. subsidiary said various-sized solid rockets, with thrusts from one to several million lbs., could then be assembled on the spot according to the demands of the mission scheduled for that day. Aerojet said huge savings are possible because of the elimination of need for new facilities, use of currently available transportation and absence of need for expensive new research and development programs.

The concept of the segmented rocket originated at Aerojet in 1957, the company said. Hardware was constructed in early 1959. More advanced design hardware was recently constructed and firings are imminent.

SEGMENTED ROCKET model that may be designed for big Air Force booster is shown by Dr. E. R. Roberts, research manager at Aerojet solid rocket plant.



PROTOTYPE SEGMENTED rocket after a static test firing last summer generated 40,000 lbs. of thrust for 10 seconds.

Atlas, Thor Engine Costs Cut More Than One-third

A drop of 37% in production costs of *Thor* and *Atlas* missile engines from 1957 to 1959 is reported by Rocketdyne Division, North American Aviation.

The cost of the engines in 1959 was $45 million, Rocketdyne said. The actual number produced is classified. At 1957 production costs, the same number of engines would have cost $72 million, the company declared.

Factors influencing the cost reduction were normal manufacturing learning curves, design improvements, budgetary and production controls utilizing advanced electronic data processing equipment, organizational innovations and special suggestion award and conservation programs.

Five *Thor* engines are now being delivered for the 1957 price of two. Three *Atlas* propulsion systems are being delivered for the 1957 cost of two. Eight engines to be clustered for the *Saturn* booster are being delivered at the cost of five predecessor engines for *Jupiter*.

A contributing factor in the cost reduction was simplified engineering design adapted from a Rocketdyne experimental engine designated X-1. The experimental engine was designed in 1958 with only eight major working components, compared with a production engine then put into service with 88 major components.

Bristol Designs H_2 Engine With Upper Stage Potential

LONDON—A research team at Bristol Siddeley Engines Ltd. has completed a design study of a liquid hydrogen-LOX engine that could be used as second stage of a system capable of launching into orbit a 13-ton manned astronomical laboratory.

Bristol calls the engine Project X. It would have maximum thrust of 100,000 lbs. and would burn at full thrust for three minutes and then be throttled back to half thrust for another six minutes. Other specifications: dry weight 1420 lbs., specific impulse (vacuum) 420 sec., mixture ratio (O_2/H_2) 6:1, length 95 in., diameter 72 in.

The system would be lifted by a booster of similar design that generates 450,000 lbs. thrust. Burning time for the booster was not specified.

Thrust control would be achieved by adjusting the flow of hydrogen and

oxygen to the gas generator. This in turn would affect the turbine power, pump speeds, propellant pressures and flows, and hence the combustion pressure. The turbine is run by hydrogen at about 1475°F, the hydrogen being heated by burning it with a small amount of oxygen.

No hardware for the engine has been produced, nor has any estimate of cost been made.

Nitrasol Solid Fuel Plant Completed by Grand Central

Grand Central Rocket Co. has completed a nine-unit commercial pilot plant designed specially for production of Nitrasol solid propellants.

The company said it is believed the plant at Redlands, Calif., is the first such commercial production unit in the country. It was completed in eight weeks. (Start of production was reported in M/R Feb. 8.)

The facility—which consists of twin mixing stations, a remote control room, a screening and filtering building, a large vacuum still unit for handling some liquid ingredients, a large vacuum oven for drying, and three storage buildings—has mixed, cast, cured and successfully test-fired about 35 Nitrasol motors.

Two contractors were employed in the construction. R. A. Darling built the mix stations, the bridge, four storage buildings and all the static conductive floors. J. D. Diffinbaugh built the Nitrasol control station.

AF Missile Overhaul Center Opens on West Coast

A rocket engine overhaul center went into operation last month at Norton AFB, San Bernardino, Calif.

The first operational *Thor* engine was received for analytical overhaul in the beginning of a complex phasing plan. By midyear, more than 2000 parts of *Thor, Atlas* and *Titan* ballistic missiles will go to Norton for repair.

Engineering technicians will tear apart three main components of the $140,000 *Thor* engine—vernier engines, turbopump and gas generator.

The San Bernardino Air Material Area at Norton, an Air Materiel Command installation, also provides a storage-maintenance responsibility for *Thor*, currently deployed in Britain by the Royal Air Force.

Patent on Hybrid Motor Granted to British Firm

LONDON—A British patent has been granted to D. Napier & Son Ltd. for a hybrid liquid-gaseous propellant rocket motor.

W. Shirley and A. L. R. Fletcher invented the motor, which is intended for use with kerosene and decomposed hydrogen peroxide. The hydrogen peroxide is decomposed by passage through a catalytic bed and the resulting oxygen and steam mixture is introduced into the combustion chamber.

The burner is an annular duct through which the gases pass at high speed into the chamber. The liquid kerosene is introduced to the duct through an opening in the interior at a direction across the flow of gas. It sprays against the opposite wall of the duct and becomes thoroughly mixed with the gases. Thus combustion occurs while the propellants are still close to the burner.

ARC Machine Mixes Tiny Batches of Propellant

Atlantic Research Corp. has developed a laboratory mixer able to mix accurately batches of liquids and solids weighing from ½ to 2 ounces.

Atlantic said it developed the mixer after it surveyed the market and found no equipment suitable for such tiny batches. It now has been placed on the market. Specifications and price list are available on request.

The machine, which ARC calls the Micro-Mixer, is completely sealed. Operation can be observed through a transparent lid. Thick walls and top make possible the safe mixing of explosives and of toxic and flammable materials. It is a scaled-down model of a sigma-blade mixer developed by ARC six years ago, which has a capacity of 3 to 8 ounces.

ARC said it has proved of great value in mixing small experimental propellant formulations, particularly when rare or valuable ingredients are used.

Army Gets Navy, Air Force Aid to Plan *Zeus* Output

The Army Rocket and Guided Missile Agency, Army Ordnance Missile Command, is exchanging information with Navy and Air Force missile agencies on the manufacture of solid-propellant motor cases. The aim is to use the best available methods in the *Nike-Zeus* antimissile missile.

AOMC said one of the studies in progress is development of maximum industrial capacity necessary to speed the acquisition of the *Zeus* system once production has been authorized. The Army has recommended that production be started, but the Defense Department has refused authorization and the necessary funds.

D-65 Coating Protects Launch Sites

by Frank G. McGuire

LOS ANGELES — A heat-resistant coating with promise of wide application in the missile and space industry has been developed by the Plas-Kem Division of Dyna-Therm Chemical Corp. The new material, designated D-65, is an "intumescent coating containing phosphates and boron flame proofing chemicals dispersed in a flexible polyurethane binder."

Applied to launching pads at Vandenberg Air Force Base, the coating completely protected cables and other vulnerable equipment on the site during an *Atlas* launching. The protective layer of D-65 has been successfully applied to areas subjected to 5000°F for 90 seconds. The original AF request for such a coating specified an environment of 2000°F for five seconds, and was aimed at protecting the *Titan* ICBM umbilical cord.

D-65 is expected to be applied to most of the areas subjected to direct blast from the rocket engines of a large missile. Previously, much of the wiring, instrumentation and other items on a pad had to be replaced after each launching. Application of Dyna-Therm's new coating will eliminate much of this disadvantage, according to the company.

Field tests of D-65 conducted at Vandenberg have used *Thor* and *Atlas* ballistic missiles as "proof of the pudding." Test temperatures have run as high as 6000°F.

As a coating for re-entry bodies, it is anticipated that D-65 will significantly reduce the amount of ablation material necessary, perhaps by as much as half.

Companies active in major ballistic missile programs have expressed satisfaction with the material's performance, and additional applications for it are being evaluated.

Firms testing the coating include RCA, Martin, Space Technology Laboratories, Douglas, Lockheed, and others, as well as the Air Force.

In operation, the coating, nominally .005" thick, swells and bubbles, then chars, to provide a layer of insulation on the surface of the equipment. Temperature extremes cannot penetrate the superficial char and the underlying layer of D-65.

COPPER coin is melted with acetylene torch on surface of D-65. Elbert Davis, Dyna-Therm vice-president, invented it.

Preparation for use of the coating is similar to applying paint, which the product resembles. After stirring, the basic D-65 formula is mixed with a thinner, D-65-1, to obtain the desired consistency for application. Under average conditions, the company says, this will vary from 10 to 50%, but extremely dry weather may necessitate a mix of two parts thinner to one part D-65. Application may be done with either brush or spray.

Drying time is about 18 hours for operational use, but only 20 minutes for setting to touch.

The liquid D-65 is 30% solids, and weighs 8.2 lbs. per gallon. Flexibility is such that no cracking is experienced over a 1/8" mandrel. The material is stable during storage and no skinning, gelling or caking occurs over a period of six months. Elongation of a .050" film is 300% minimum.

Orders for the D-65 coating currently amount to well over half a million dollars. Exclusive sales agent for the product in this country and Canada is Swedlow, Inc.

Gamma Device Finds Flaws In Solid Rocket Motors

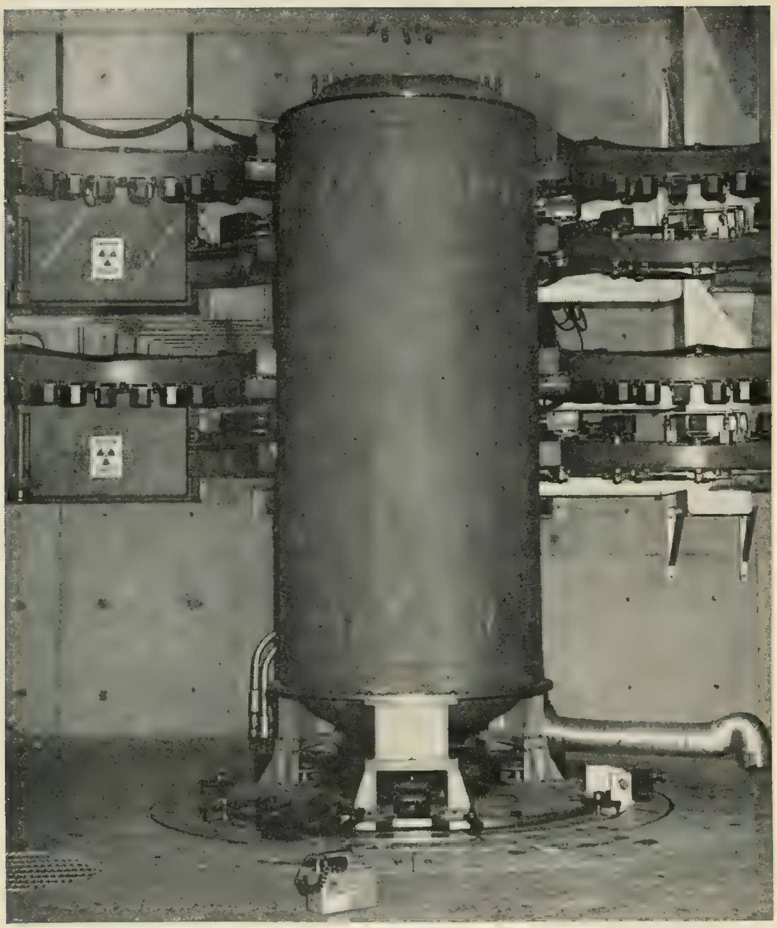
SACRAMENTO, CALIF.—A gamma radiation device to exercise tight quality control over solid propellant rockets has been developed by Aerojet-General and the Navy. The device, named GIGI (gamma installation for grain inspection), uses a cobalt-60 source and can detect flaws as small as .03 inches in a rocket motor several feet in diameter.

Thus far, tests have been conducted with the *Polaris* fleet ballistic missile, using the permanent facility here. Two mobile units have also been produced, one for Cape Canaveral and one for the Naval Weapons Annex at Charleston, S.C.

The inspection process consists of placing the motor in a concrete test cell, sealing it to protect operating

Physical Properties of Dyna-Therm D-65

Percent solids	(percent)	30, plus or minus two
Weight per gallon	(pounds/gallon)	8.2
Viscosity, Stormer	(400 grams, 30 seconds)	104 KU
Viscosity, Brookfield	(#4 spindle, 20 rpm)	2500 centipoise
Drying time	(Average brush coat, 5 mils dry)	
Set to touch Through dry		20 minutes 18 hours
Shore A Hardness		70, plus or minus 5
Color		White
Reflectance	(15 mils thickness)	77 percent at 45°
Flexibility	(.050" film)	No cracking over 1/8" Mandrel
Can Stability		No skinning, gelling or caking over a period of six months
Elongation	(.050" film)	300 percent minimum
Dielectric strength		97-130 volts per mil



FIRST-STAGE Aerojet-General solid propellant rocket motor for *Polaris* is ready for inspection by "GIGI." "GIGI's" arms, containing 48 detectors, circle the motor. Gamma photo beams, generated from cobalt 60 sources, pass through motor and propellant and are picked up by detectors. Analysis of pulses determines whether there are voids or cracks within the propellant.

personnel, and then hydraulically placing a cobalt-60 pill in the rocket motor's core. Radiation detection devices, located on encircling arms, are located about the motor to measure intensity of the gamma radiation getting through the propellant and casing.

After completing measurements in this initial position, personnel move the motor hydraulically to the next position, and a new set of measurements is completed. This is continued until the entire motor is inspected.

Data from the various readings are placed on IBM cards and run through a computer for evaluation and analysis.

Normal motor conditions will allow a steady rate of scintillation to be measured, and a sudden rise in this rate gives notice of a void in the propellant. Sensitivities have been demonstrated to 0.1%.

The Sacramento installation uses two radioactive sources of 70 Curies strength each. For propellant-to-case bonding inspection, two 20-Curie sources are used.

Hydro-Tests Made On *Minuteman, Polaris* Cases

Some of the problems in the fabrication of second and third stage *Minuteman* motor cases and second stage *Polaris* chambers have been solved in an extensive series of hydrotests on sub-scale models at the Lycoming Division of the Avco Corp., Stratford, Conn.

Experimental tubes in two sizes were burst by internally induced water pressure in a study designed to determine the exact heat treatment necessary for maximum strength.

All of the tubes were of the same low alloy high strength steel as the full sized chambers but the heat treatment of each was different. One of the problems was the accurate prediction of the point of failure on the miniature cases.

Water pressure in the test cases was gradually increased until rupture occurred. Three axial and three hoop stress gauges continually recorded the stresses within the test model throughout the run. All of this information plus the crack patterns and precise points of failure were evaluated to determine the exact heat treating method now used in the production of the full scale cases.

Lycoming is producing the *Minuteman* and *Polaris* cases for Aerojet-General, Sacramento, Calif.

Huge New Furnace to Treble Vacuum-melted Ingot Size

Vacuum melted ingots up to 50 inches in diameter and weighing over 40,000 lbs. will be possible with the completion of the world's largest vacuum-melting furnace at Allegheny Ludlum's Watervliet Works in New York.

Clark W. King, executive vice president, said that ingots more than three times the size of those currently available can be produced with some modifications of the auxiliary facilities of the new furnace.

The consumable electrode vacuum melting process consists of the remelting, under vacuum, of cylindrical electrodes of a specified alloy initially formed in a conventional electric furnace. The vacuum serves the dual purpose of eliminating contaminating elements and drawing off the undesired gases formed during the remelting.

The result is a high degree of metal cleanliness, improved ingot soundness and workability, and general improvements in the mechanical properties.

The new furnace will be built by the Lectromelt Division of the McGraw-Edison Co.

New Facilities for Shock Testing Completed

Extremely rapid temperature shock testing of missile components has been made possible at the American Laboratories Division of American Electronics, Inc., through the installation of the largest liquid CO_2 systems on the West Coast.

Designed and built by the Cardox division of Chemetron Corp., the 22-ton unit permits maintaining 65°F. in a chamber 37 ft. by 15 ft. by 11 ft. with heat loads up to 500,000 BTU per hour.

American Laboratories specialize in environmental testing for military commercial and industrial uses with emphasis on electronic and space applications.

Novel High-Performance Plastic Made by Pennsalt

A new polyvinylidene fluoride resin has been developed by Pennsalt Chemicals Corp.

The polymer has high resistance to heat, light and chemicals. Mechanical strength, thermal stability, ultraviolet radiation stability and ease of fabrication round out the substance's properties.

Designated RC-2525, the resin is a crystalline, high-molecular-weight polymer of vinylidene fluoride. Containing over 59% fluorine by weight, it has the stability and inertness characteristic of highly fluorinated hydrocarbons.

RC-2525 is not available commercially, but Pennsalt has a large pilot plant in operation. Field test results by industry will provide further information on its uses.

Auto-Information System At Military Agency

The groundwork and first phase of a massive transition to automation is underway by the Armed Services Technical Information Agency at Arlington Hall, Va. The agency, which supplies Department of Defense agencies and their contractors with copies of research reports submitted by and for military agencies, has nearly a million documents on file.

ASTIA started off with a Remington-Rand USS-90 Univac Solid State Computer. This punch card system has as its first objective speed-up of the flow of informational tools to military contractors. Magnetic tapes will be added next July to automatically identify reports without mention of ASTIA catalog numbers.

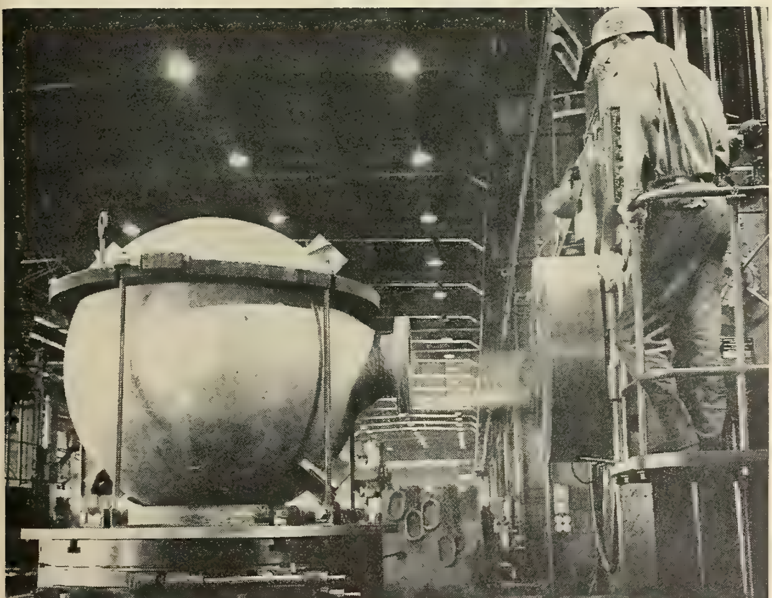
Tapes will also accelerate checking for duplication, mechanized compilation of cumulative indexing of the agency's bulletin and information retrieval. Within another year, ASTIA hopes to copy all 7 million-plus catalog cards on magnetic tape—making possible automatic printout, at 600 lines per minute, of bibliographies together with a full descriptive abstract of each reference.

The final stage will be a Randex (random access) system—providing greater flexibility in compiling reference information. Until an automatic data processing system went into operation last month approximately 1,200 copies of reports had to be hand tailored every day.

Thiokol Improves Solid Propellant Fuel Binder

Thiokol Chemical Corp. has developed an improved version of its polysulfide solid propellant fuel binder. The new fuel, C-12, was developed at the Trenton, N.J., research center. It contains more hydrocarbon than earlier formulations, increasing specific impulse.

Preparing Polaris Popping



THIS GIANT steel flask being neck-machined will provide the compressed air boost needed to pop a *Polaris* missile out of the water when fired by a submerged nuclear vessel. Manufactured by Lukens Steel Co., Coatesville, Pa., the flasks are to be installed in each of the sub's 16 firing tubes.

French Put *Veronique* Through Tests

by Jean-Marie Riche

PARIS—Considerable high-altitude scientific testing has been done the past few weeks with *Veronique* exploration rockets at the Colomb-Bechar Missile Range in the Sahara Desert.

The French rockets are equipped to emit a vertical "candle-shaped" cloud of sodium-potassium through which the direction and speed of winds are studied as well as the temperatures, pressures and densities of air in the upper atmosphere.

Designed by the Laboratoire de Recherche Balistiques et Aerodynamiques of Vernon, the *Veronique* has been sponsored by the Direction des Etudes et Fabrications d'Armament (Army) for the Comité d'Action Scientifique de la Défense Nationale.

Testing began seven years ago, with 15 launchings made to develop the vehicle itself. It was not until March, 1959 that the missile carried a scientific payload.

Veronique is a single-stage test vehicle, 23 ft. high, 27 in. in diameter. It has a conic head and rectangular fins, and is propelled by nitric acid and terebenthine. Total weight is 3086 pounds—excluding payload—882 for the casing, 2204 for propellant.

• **Wire guided**—Launched vertically from a subsurface launcher (71 in. deep), the rocket is initially guided by wires for about 300 ft. Accelerations vary from 2 to 9 g.

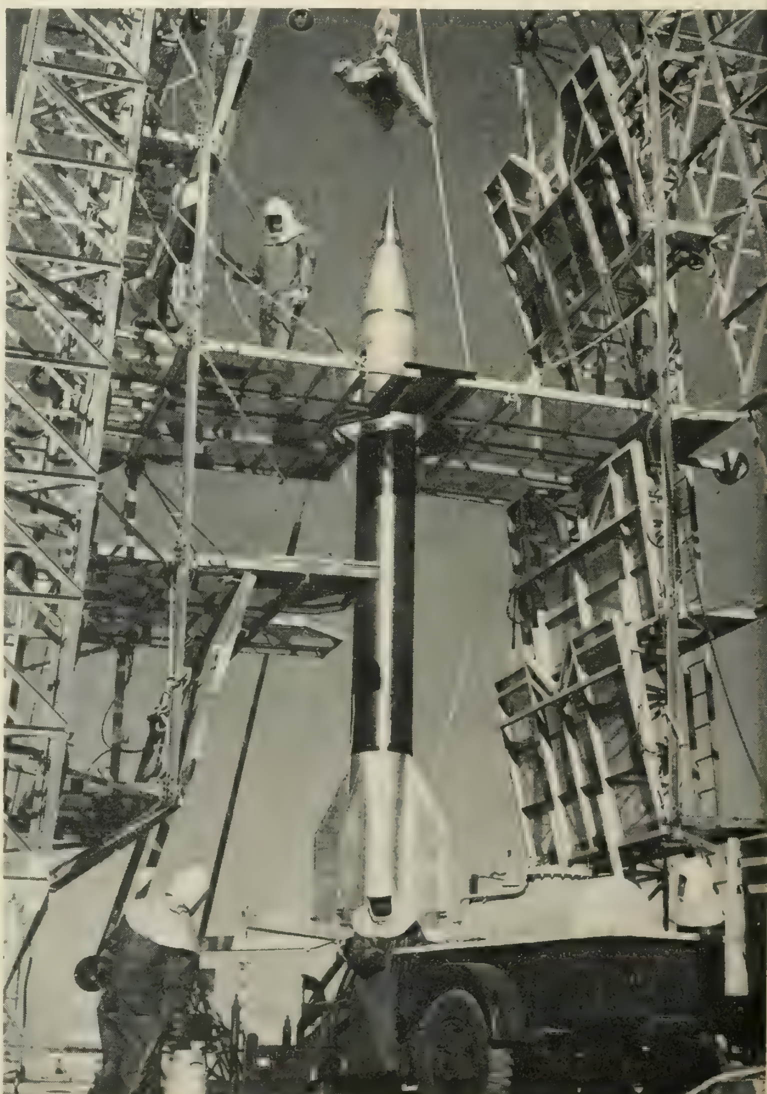
An altitude of 125 miles has been reached by a *Veronique* during recent experiments, and total capability is 137 miles with a 132 lb. payload.

A small transmitter installed in the rocket sends readings from the scientific instruments carried in the nose cone and higher part of the cylindrical body. Information about acceleration speeds, vibrations, temperatures, etc. of the rocket itself also are relayed to observers.

The smoke emitter contains an inflammable mixture, "thermite," consisting essentially of aluminum powder and iron oxide. Inflammated by powder 60 seconds after takeoff, a sizeable quantity of heat is released which vaporizes small die-shaped bits of solid sodium contained in the mixture. At an altitude of about 31 miles, this gas is emitted through small holes in the nose cone of the rocket, creating the "candle-shaped cloud."

Through photographic, photogrammetric and cinematographic observations of variations of the cloud, deductions are made about the speed of the winds as well as about the pressure and temperature of the atmosphere.

• **Launch at Dawn**—Conditions for the launching of the *Veronique* vehicles are very strict. A perfect vertical position must be assured. Success of the scientific experiments is best achieved if launching is at dawn or twilight when the sun is at a maximum of 9° under (dawn) or at least 6° under (twilight) the horizon, when visibility of the cloud is best. The "candle-shaped" cloud cannot practically be observed before the rocket reaches a height of 50 miles, an altitude corresponding to the dissociation of molecular oxygen into atomic oxygen. Under this altitude, sodium atoms are not "excited" by the sun and



HOODED CREWMEN refuel a *Veronique* **in position under blazing Sahara sun.**

the cloud is not bright enough to be observed.

Veronique will serve other scientific purposes in the future. Studies of the propagation of electromagnetic waves in the high atmosphere (in liaison with the Centre National d'Etudes de Telecommunications) for the measurement of diffuse light, the utilization of a spectrograph of mass and biological experiences including the transportation of live animals and the recording of their physiological reactions and other studies are planned.

Data obtained from all tests also will be used in the preliminary work now being done in France on the design of an IRBM.

Sweden To Get US *Nikes* For High-Altitude Research

STOCKHOLM—Professor Hannes Alfven of the Institute of Technology, Stockholm, has announced that the U.S. has agreed to sell Sweden a number of *Nike* rockets.

The rockets will be used in a high-altitude research programme planned by the International Meteorological Institute, Stockholm (particularly in connection with an investigation of the noctilucent clouds) and in the measurements of ionized radiation associated with the Northern Lights to be made by the Kiruma Observatory.

British Get *Honest John*

Within the next three months, the first shipments of the U.S. *Honest John* missile will be in the hands of the British Army. It will be supplied to the 39 Heavy Regiment, Royal Artillery, which arrived at Sennelager, Germany, last month with no artillery equipment.

Fourth British Missile Destroyer Keel Laid

LONDON—The fourth of the guided missile destroyers being built for the Royal Navy was laid down at the Belfast yard of Harland and Wolff, March 1. It is to be called the Kent, since all vessels will be named after British counties.

On Feb. 26, the third destroyer's keel—the London—was laid down at the Wallsend-on-Tyne (Northumberland) yards of Swan, Hunter and Wigham Richardson Ltd.

Devonshire, the first of the class was laid down on March 9, 1959 at the Birkenhead yards of Cammell Laird and Co., and is due to be launched this summer. Next will be the Hampshire.

These four ships will be the first to join the British fleet armed with the long-range guided missile *Seaslug* and the short-range *Seacat*, which are now in production.

British Missile Costs Soar

by G. V. E. Thompson

LONDON—Great Britain is finding that the cost of missile defense will be considerably more than she had envisioned. A report written by Sir Edmund Compton, Comptroller and Auditor-General came in the nature of a rude shock to budget-minded Britons.

The development cost of the first weapon, which he calls Type A (probably *Seaslug*), was originally estimated at between $2.8 and $4.2 million, to be spread over a period of years. This contract was issued February 1949—actual expenditure under the main contract up to the start of intensive firing trials was $25 million—or $17 million at 1949 values.

However, it appears that the Treasury had not understood that the original estimate referred to payments to the main contracts only and to development up to but not including the intensive firing trials. The latest estimate of the direct cost of developing the missile and its control and guidance systems is over $110 million.

• **Profits reduced**—Complaints of unsatisfactory progress were made on more than one occasion between 1953 and 1956. In August 1956, the Director of Contracts of the Ministry of Supply negotiated a reduction of over $100,000 in the profit allowed to the contractor. The Ministry then assumed responsibility for coordinating the activities of all firms concerned in the project. Delivery of the missiles for service is now planned to begin at a date five years later then originally called for, but still in time to meet the dates when the service department will actually require them.

Type B (probably *Thunderbird*) is now expected to have a development cost of $75 million. In 1950 it was tentatively estimated to be $7 million, but this figure made no provision for the cost of manufacture or for evaluation of missiles for acceptance trials.

No firm prices for production of the missiles have yet been agreed, but the Ministry's estimated price in Nov. 1958 was more than double the estimate given to the War Office in Sept. 1956.

In the case of a third weapon, Type C (probably *Firestreak*) a contract for design and development was placed in 1952, when the cost was expected to total about $11 million, spread over five years. However, the Ministry emphasized that they had no real experience on which to base cost calculations.

During development it became possible to build improved performance into successive models, and eventually the *Mark IV* weapon represented so substantial a change from the original concept that fresh approval for the project was obtained and a separate development contract made.

The U. K. Treasury then gave their approval in principle for the *Mark IV* weapon at an estimated total cost of $56 million. This was in addition to a revised total estimate for the *Mark I* of $65 million. *Marks II* and *III* were discontinued.

The size, complexity and urgency of the Spadeadam project (rocket test-bed facility in Cumberland, managed by Rolls-Royce, and at which the large engines for *Blue Streak* are tested) precluded pre-contract design. It was considered necessary to employ a consortium of building and engineering contractors on a cost-plus fee basis under a Ministry of Works team. Spadeadam is now expected to cost $70 million instead of the original $28 million. An enquiry into the whole financial position was held last summer and control is now said to be functioning satisfactorily.

Semiconductor Line Introduced

With an eye to the opening of the annual IRE Convention and Exposition in New York, Texas Instruments, Inc., announces a vastly increased line of semiconductor products.

Of greatest import is the appearance of a standard "Solid-Circuit" semiconductor network. Developed over a year ago as a prototype item, the TI type 502 binary multivibrator, is a commercial off-the-shelf item, three years ahead of industry predictions, according to the Semiconductor-Components Div.

Expected to find wide application in missile and airborne circuitry, other typical Solid Circuit networks have already been utilized; they include logic blocks, gates, oscillators, NOR circuits and multivibrators.

The type 502 multivibrator can operate at a 200-kc repetition rate. The device measures only 0.250" x 0.125" x 0.031" and contains the equivalent of 16 conventional components, one-hundredth the size of an equivalent transistorized printed circuit device. The unit is designed to operate with a 6-volt power supply. Necessary input and output characteristics have been provided so that the type 502 unit can be interconnected for use as a shift register, binary counter, or set-reset flip-flop.

Solid-Circuit semiconductor networks are produced by techniques which are extensions of TI-developed mesa transistor production techniques. Diffusion, oxide-masking, evaporation, and chemical forming are used to make a single-crystal semiconductor wafer perform the function of a complete circuit. Ultrapure materials are used throughout to reduce contamination and increase reliability. The unit is encased in a glass-to-metal hermetically sealed package. Quantity prices: less than 100, $450; 100 or more, $300.

Other new produces include sensors, diodes, and regulators of silicon and gallium arsenide.

• **Photovoltaic sensors**—An entire line of photovoltaic silicon sensors was announced that includes diffused silicon solar cells, available either singly or in a shingle array, miniature vertical and horizontal light sensors for punched-card readers and a unique null-sensing device for use in ultrasensitive instrumentation.

The silicon null-sensing device, LS 221, consists of two matched sensors mounted in a subminiature dielectric case only 0.44 in. long. The sensors are connected to indicate a null when an equal amount of light is falling on each sensor. Positioned behind a moving needle or in front of a moving beam of light, the device is capable of remotely indicating minute variations in intensity. It is expected to find wide application in photo-mechanical tracking systems, servo systems, gravity meters, galvanometers, curve followers and balanced choppers.

The type LS 222 horizontal light sensor for card reader is packaged in a subminiature glass case measuring only 0.50" long by 0.08" in diameter. It produces an output of more than 250 microamps with a load of 1000 ohms under 1250 foot-candles of light.

• **Tunnel diodes**—Four new gallium arsenide tunnel diodes have been designed for specific applications in high-speed computer circuitry such as logic circuits, amplifiers, oscillators, and general computer purposes.

The IN650 Series, packaged in the lightweight standard JEDEC TO-18 case, provides guaranteed peak currents up to 10 milliamperes ±2%, large voltage swings, highest peak-to-valley ratios (greater than 15 to 1), guaranteed forward voltages up to 1.1 volts ±5%, and high-temperature operation up to 150°C.

These new gallium arsenide tunnel diodes, already in full production at Texas Instruments, are priced competitively with germanium tunnel diodes presently available to industry only on a sample basis.

• **Other diodes**—A gallium arsenide diffused junction varactor diode—believed to be the first—is designated the varactor XD 500. It is encased in a reversible-polarity, double-ended, ceramic microwave package.

The XD 500 offers a junction capacitance of 0.1 uuf min to 1.0 uuf max at zero bias, a Q of 30 measured at 2 kmc at –2 volts. When referenced to –6 volts at 2 kmd, Q is typically 45. The cut-off frequency is 60 kmc at –2 volts and 110 kmc or greater when measured at breakdown voltage. The shunt capacitance variation of the XD 500 varactor follows the minus ½ power law. The XD 500 has an extremely low inductance with a 0.4 uuf package capacitance measured at 100 kc.

Circle No. 225 on Subscriber Service Card.

1000 Hour Gyros

A new type of rate gyro for missile and aircraft systems with a guaranteed operating life of at least 1000 hours has just been announced by Gyro Dynamics Division of Darco Industries, Inc., a wholly owned subsidiary of United States Chemical Milling Corp.

Basis for the unusually long life of these gyros is an inverter actually built into the package which permits the use of A.C. motors for power. The gyros will operate directly from any D.C. current source without modification.

Until now, the average operating life of a gyro was approximately 200 hours, due mainly to the use of D.C. motors, which by the nature of their design, wear at a fairly rapid rate. It

was recognized that A.C. power was much more satisfactory but most missiles carry only D.C. current. This meant that an inverter had to be designed into the system before A.C. motors could be used, which resulted in more weight and additional space requirements.

The Gyro Dynamics product was designed around an entirely new concept which includes a built-in inverter as part of the basic unit without increase in overall size and with an actual reduction in weight over standard gyros of similar capacity. Environmental and in-use tests have shown that these gyros will perform to specification for at least 1000 hours. This new product is being offered on an "off the shelf" basis or may be modified to meet any special specifications.

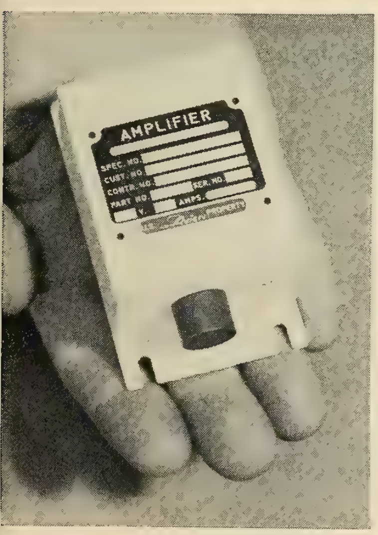
Circle No. 226 on Subscriber Service Card.

Miniaturized Amplifier

Development of a miniaturized D.C. Amplifier, designed expressly for low-level signal amplification in telemetry and other applications, has been announced by Avien, Inc. First use of the new unit will be as part of the flight instrumentation package on the Air Force *Minuteman* missile, now under development at Boeing Airplane Company.

The Company also announced that the characteristics which qualify the product for the *Minuteman* make the unit equally adaptable to a wide range of other missile projects.

The D.C. Amplifier is 6.5 cubic in. in size and weighs 10 oz. It has been designed to eliminate the problem of instability normally associated with amplification of D.C. signals. This has been done by first converting the signal to A.C., and, after amplification, transforming it back to D.C.



A solid-state modulator is employed for the conversion to A.C. Operational difficulties characteristic of mechanical choppers are avoided by the absence of moving members and contacts in the modulator.

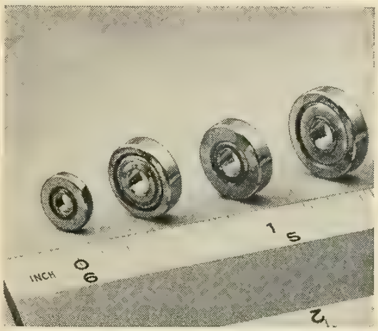
Less than 1.4 watts are required for performance of the Amplifier, which has an output impedance of less than 1000 ohms, and an input impedance of over 50,000 ohms. A linearity of 0.1% of best straight line is achieved, voltage gain is 50 to 200 and output voltage is 0-5 volts.

Circle No. 227 on Subscriber Service Card.

Thin-Width Bearings

A series of thin-width precision instrument bearings designed for use in synchros, gear trains, potentiometers, servos and small motors is now available from Miniature Precision Bearings, Inc.

Featuring a high outside diameter/-width ratio, the new MPB bearings were developed originally for use in synchros where precision and reliability are prime requisites. Found to be suited for other applications, nine thin-width bearings were incorporated into the standard series which is available without premium charge. The relatively large O.D. enables designers to use economical through-bored and through-ground housings, resulting in more efficient production and improved bearing alignment. The narrow width of the new bearings saves space, making possible the use of longer stators and rotors in synchros and small motors, increasing power without adding to the overall length or diameter of the unit.

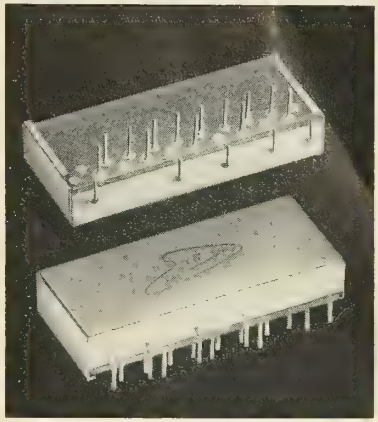


Made to ABEC class 7 tolerances, thin-width bearings are available from MPB factory and area office stocks in nine sizes with outside diameters from .2750 in. to .5000 in. and bores from .0937 in. to .1875 in. The new bearings are manufactured to the same exacting specifications as standard MPB bearings. For this reason the new bearings have the same levels of low torque and the smooth running characteristics of other MPB bearings. Standard material for balls and rings is 440C stainless steel. Open, single and double-shielded bearings are included in the series.

Circle No. 228 on Subscriber Service Card.

Digital Logic Module

Featuring versatility, compactness, and ruggedness, the Tele-Dynamics Type 6000A Logic Module is now available for a wide range of applications in digital systems and test equipment.



The module, containing two solid-state switching circuits, can be interconnected to form all of the major building blocks required for digital systems.

Each switching circuit contains a 4-input diode gate, an inverting amplifier, and a transition-triggered pulse generator. Used singly, or in combination, the logic module functions as a NOR gate, flip-flop, binary counter, delay flop, or as a shift register stage.

The logic module operates at a maximum pulse repetition rate of 5 megacycles. The inverting amplifier output has a 40 millimicrosecond rise time and an 80 millimicrosecond fall time. The pulse output occurs on a positive-going transition. The pulse has a half-amplitude duration of 100 millimicroseconds. Power consumption is less than one watt per module.

Circle No. 229 on Subscriber Service Card.

Audio Signal Generator

A dual function (sine and square wave) audio signal generator, Model 50, has been designed by Packard Bell Electronics specifically for measuring distortion in hi-fi amplifiers and the frequency response of test equipment, hi-fi amplifiers, tone controls and phonograph equalizers.

The Model 50 also provides precise measurement of amplifier input and output impedances and loudspeaker resonant frequencies. It is continuously tunable from 21 cps to 250 cps (fre-

quency reference of 200 cps), and can be used for tuning bass-reflex enclosures and for determining unknown audio frequencies and the resonant frequency of LC circuits.

Specifications: fully regulated power supply (105V to 130V); continuously variable output signal to 15V rms MAX; hum level .001% of maximum output; 2% or less harmonic distortion from 30 cps to 100 kc; accurate to plus or minus 2% or better.

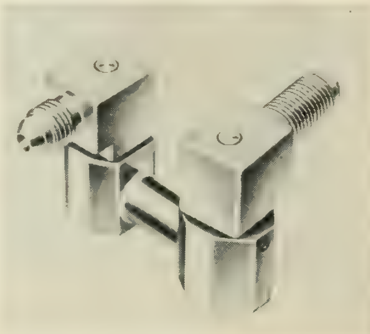
Circle No. 230 on Subscriber Service Card.

Swivel Connectors

Airaterra, designers and marketers of products manufactured by Roylyn Inc., announces that its new line of ball bearing swivel connectors is now available for aircraft, missile and industrial pneumatic or fluid applications.

These advanced design connectors boast low rotating torque values under full operating pressure due to the balanced pressure feature incorporated by Airaterra engineers.

Lightweight, and available in most materials, the Airaterra Swivel Connec-



tors may be obtained in single or multiple swivels.

An example of Airaterra's new line is this twin mounted swivel, designed and qualified in accordance with MIL-J-5513 A. The connector is compact, made of stainless steel and weighs but 9 oz. It is bulkhead-mounted to allow for misalignment of connecting lines. This Airaterra design operates from 0 to 3000 psi, with proof at 4500 psi, and burst at 7500 psi. The temperature range is from minus 65°F to plus 275°F.

Circle No. 231 on Subscriber Service Card.

Servo Valve Package

A servo valve-hydraulic motor package announced by Vickers Inc., Division of Sperry Rand Corp., is used to control accurately velocity and position of radar drives, missile guide vanes, reels, winches, hoists, flight controls, stabilization devices and other missile and ground support applications. The servo valve modulates flow to the motor producing speeds proportional to electrical input signals.

The Vickers miniaturized servo valve weighs only .53 pounds, which holds the valve-motor package size and weight to a minimum dry package weight of 2.7 pounds. The entire valve-motor unit occupies approximately 60 cubic inches of space. Models with integral relief valves weigh 2.9 pounds with no sacrifice of additional length.

The package is designed to cover any speed range between 10 to 20,000 rpm with a maximum output running torque or approximately 30 inch pounds at 3000 psi supply pressure.

A differential current of only —8 milliampere actuates the valve control spool. Valve configuration assures a high degree of linearity, low null shift with temperature, low hysteresis and increased reliability due to elimination of unnecessary tubing and fittings.

Circle No. 232 on Subscriber Service Card.

New Literature

OIL TANKS. Engine oil tanks for air missiles are discussed in a new 8-page catalog from United Aircraft Products, Inc. Since tanks are normally custom fabricated, the literature deals primarily with UAP capabilities in tank design, production, and testing. Engineering requirements are listed and illustrated, and a number of unusual configurations are shown. The literature also details UAP's quality control and qualification testing procedures, while the back cover is devoted to a glossary of oil tank terms and a specification table of the various tanks made by the firm which range from 1 to 15 gallons in capacity.

Circle No. 200 on Subscriber Service Card.

COOLING SYSTEMS. Four new liquid nitrogen cooling systems for infrared detector devices are described in a 6-page folder available from Linde Company, Division of Union Carbide Corporation. These cooling systems, developed to customer's specifications, increase the range and long wave length response of IR ray detectors. The four types are: integrally-mounted cell; liquid feed-vacuum insulated line; liquid generator to cryostat; and liquid feed-uninsulated lines. The folder contains information on design features, performance data and specifications.

Circle No. 201 on Subscriber Service Card.

VOLTMETERS. Panel-mounting electronic voltmeters ("PMEVs") expressly designed for continuous monitoring of critical parameters in systems and consoles, are described in a new folder of data sheets issued by Metronix, Inc.

Circle No. 202 on Subscriber Service Card.

Explorer VIII Launching Misfires

Upper-stage ignition failure apparently defeated NASA's try last week to put a pint-sized *Explorer VIII* radiation satellite into an elliptical earth orbit.

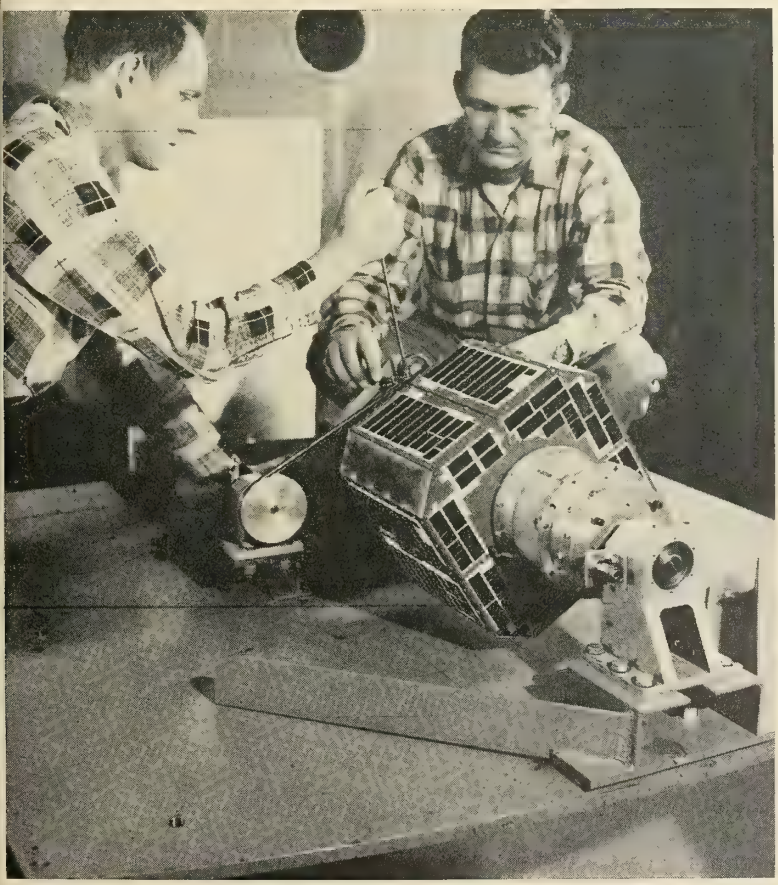
Billed as the most significant "radiation" belt experiment sent aloft to date, *Explorer VIII*'s payload and elliptical orbit were to have been much like those of the larger "paddlewheel" satellite *Explorer VI*. A correlation of the information from both satellites was to have given scientists definitive dimensions and accurate velocities of the charged-particle belts enveloping the earth.

The satellite was launched toward a highly elliptical orbit of 28 degrees from the equator; its elliptical orbit would have carried it out to about 33,000 miles at apogee and within 200 miles of the earth at perigee, with an orbital period of 17 hours.

The launch vehicle was a *Juno II*, consisting of a modified *Jupiter* provided by ABMA, and a three-stage JPL high-speed cluster.

Explorer VIII's payload, devised and built by Dr. James A. Van Allen's Physics Department of the State University of Iowa, was a 21-by-7-in. cylinder containing solar cells for a permanent energy source and five sensitive energy particle detectors.

These five detectors were capable of detecting electrons below 20,000 electron volts—the first payload with such a capability—and also detecting the charges of the highest-energy particles. The detectors—singly and in combination—were designed to reveal the structure of the charged particle belts and their fluctuations, this information available after the satellite had made many passes through the belts, observing them in various stages of quiescence and activity.



ILL-FATED *Explorer VIII* satellite shown being prepared for centrifuge test at Cape Canaveral prior to the March 23 launching.

Another experiment, rapidly becoming a standard item in newer satellites, was to measure internal and external temperatures.

Data reports to ground stations were to be by a 300-milliwatt transmitter operating at 108.03 megacycles. This type of transmitter is capable of broadcasting five channels of information continuously.

The basic power supply was two pounds of nickel cadmium batteries, recharged by 1184 solar cells mounted on the box-like structure surrounding the cylindrical instrument package. The cells are protected by glass slides .006 of an inch thick, and are made by Hoffman Electronics.

A destruct mechanism operated by a timer would have silenced the transmitter after one year of operation.

Explorer VIII marked the sixth firing of the Von Braun team's *Juno II*, which previously has launched such successes as *Pioneer IV* and *Explorer VII*.

Responsible for tracking *Explorer VII* and recording its findings was the Goddard Space Flight Center's Space Operations Control Center. Micro-lock stations participating in the experiment include those at Aberdeen Proving Ground, Md., Cape Canaveral, Fla., Huntsville, Ala., Atlantic, N.C., Bermuda, Fort Monmouth, N.J.; and Mayaguez, Puerto Rico.

NASA Readies Broad Report on Its Activities

A NASA handbook of interest to the missile/space industry will be available from the Superintendent of Documents, Government Printing Office, Washington, 25, D.C., in the near future.

Entitled the "Second Seminnual Report to The Congress," the 269-page manual contains a history of NASA activity, including the launches to date, the contracts and research grants let, and the research papers published.

contracts

NAVY

$356,000—**Sylvania Chemical and Metallurgical Division**, for development of molybdenum alloy in sheet form for rockets and missiles.

$40,000—**Southwestern Industrial Electronics Co.**, Houston, for producing equipment for use in power supply systems for *Polaris*.

ARMY

$22,647,800—**Nortronics Div., Northrop Corp.**, for continued production and engineering work on *Hawk*. (**$20,883,000** for follow-on production of missile airframe items and ground handling equipment, balance for research and development.)

$18,821,851—**Pan American World Airways, Inc.**, for setting up and operating an "electronic environmental test facility" at the proving ground near Ft. Huachuca, Ariz. **Bell Aircraft's Avionics Div.**, subcontractor received **$7,600,000** for its part in the program.

$2,250,000—**Lear, Inc.**, Santa Monica, Calif., for gyroscopic reference units for *Nike-Zeus*. Subcontract from **Bell Telephone Laboratories, Inc.**

$1,491,499—**Western Electric Co.**, New York City, for replenishment spare parts, repair parts and components for *Nike*. (Sixteen contracts.)

$528,429—**Douglas Aircraft Co.**, Santa Monica, for replenishment spare parts, repair parts and components for *Nike*. (Six contracts.)

$300,324—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering, design, layout development, documentation, fabrication, assembly and test work, ground services equipment, *Saturn*.

$212,370—**Southwestern Industrial Electronics Co.**, Houston, for airborne DC amplifiers for *Saturn*.

$195,950—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering, fabrication and manufacturing services for *Saturn* second-stage adapter, components, subassemblies and related tooling.

AIR FORCE

$2,322,000—**Radiation, Inc.**, Melbourne, Fla., for airborne telemetry systems for the *Titan*. Subcontract from **AC Spark Plug Div. of General Motors.**

$236,408—**Southwestern Industrial Electronics Co.**, Houston, for production of components for *Titan*. Subcontract from **Martin Co.**, Orlando.

$118,938—**University of Minnesota**, for electron-spin resonance studies of selected solids.

$60,000—**Western Reserve University**, for research on positron annihilation reactions in condensed materials.

$54,958—**Oklahoma State University of Agriculture and Applied Science, Research Foundation**, Stillwater, for research directed to the development of experimental apparatus for measurement of micrometeorite damage to surface of surface of space vehicles.

$46,467—**Barkley & Dexter Laboratories, Inc.**, Fitchburg, Mass., for study of global gravity measurements.

$45,254—**New York University**, for continuation of research investigation in control systems.

$40,175—**University of Pittsburgh**, for research on "flash spectroscopy and flash fluorimetry in photosynthetic studies."

$40,000—**Northeastern University**, Boston, for design, construction and testing of instrumentation for investigation of the upper atmosphere.

George S. Vermilyea: former executive vice president, named president, Nems-Clarke Co., a division of Vitro Corp. of America. He succeeds **Allen S. Clarke,** president since 1954, retiring after 47 years in communications and electronics. Clarke will continue with Vitro as marketing and product development consultant to Nems-Clarke.

VERMILYEA

Vitro also announced these changes: **Vernon M. Setterholm,** formerly director, Vitro's Silver Spring Laboratory, promoted to vice president, Nems-Clarke; **Wayne G. Shaffer** promoted from associate director to Silver Spring Laboratory director; **John C. Geist** promoted from technical operations director to associate laboratory director.

David S. Lewis: named senior vice president-operations, of McDonnell Aircraft. He will have responsibility for engineering, manufacturing, procurement and quality control, customer service, foreign service, contracts and project management.

Charles J. Foskett: now manager of the Radio Corp. of America's new BMEWS Operations Liaison Office at Laurence G. Hanscom Field in Bedford, Mass. Foskett previously held the position of manager of programing and manufacturing coordination, in which he is succeeded by **Harold M. Emlein,** former operations manager of the Industrial and Automation Division.

Dr. Morton B. Prince: Formerly vice president - research and development, appointed vice president and general manager of Semiconductor Division, Hoffman Electronics Corp. Former vice president **Maurice E. Paradise** has been named to corporate vice president in charge of product planning. Prior to joining the firm in 1956, Dr. Prince was a member of the Bell Telephone Laboratories team that developed the first silicon solar energy converter.

PRINCE

Benjamin H. Ciscel: chosen general manager of Vought Electronics Div. of Chance Vought Aircraft, Inc. Ciscel is former senior vice president and member of the board of directors of Electronics Specialties Co. of Los Angeles.

Borg-Warner Corp.'s Pesco Products Division announces three appointments in the engineering department: **J. F. Murray,** to director of engineering; **Thomas D. Carpenter,** manager, future products planning; and **Louis J. Schafer,** project manager.

Leonard J. Sacks: succeeds **Dean Daniels** as Western District Sales Manager for General Electric's Silicone Products Dept. Daniels moves to Sales Manager for GE's Insulating Materials Dept.

Harold H. Dice: general manager of the Allison Division since March 1, elected vice president of General Motors Corp. by GM's Board of Directors. Dice was Allison assistant general manager for seven years preceding his promotion to general manager, and has been with GM for more than 30 years.

DICE

Richard B. Uhle: named to the new post of executive assistant, planning, to the vice president and general manager of Defense Operations, Avco Crosley Division.

John F. Carr: appointed director of contracts for AC Spark Plug, the Electronics Division of General Motors. He succeeds **Alvin B. Goodspeed,** recently promoted to director of sales, AC-Milwaukee.

The promotions of **John R. Halligan** to vice-president and secretary and **Edward Bishop, Jr.,** to treasurer have been announced by The Hallicrafters Co., Chicago electronics firm.

James E. Kirch: new navigation section head for Motorola's Western Military Electronics Center. He will supervise R&D projects relating to advanced hyperbolic navigation systems, new types of propagation and field strength instrumentation and similar low frequency areas of interest.

E. B. Newill is retiring as general manager after 17 years with Allison; he has been a GM vice president since 1948.

Walter H. Wiewel: retires from active service as senior vice president, Crucible Steel Co. of America, but will continue to be associated with the company as a consultant. His retirement culminates a 50-year career in the steel industry.

REPUBLIC AND FOKKER CONTRACT: Republican Aviation Corp. has acquired a substantial minority interest in the Royal Netherlands Aircraft Factories.

Although major projects for the European combine will be aircraft for NATO and the USAF in Europe, it is expected that in the future other modern weapons systems will be added. A drone reconnaissance vehicle and development of vertical and short takeoff aircraft have been mentioned.

Fokker is at present responsible for the Hawk missile in Europe, as well as the F-104G Starfighter and the Breguet 1150 Atlantic and the F-27 Friendship.

Current U.S. and European spares production may be placed at Fokker pending the transfer of U.S. Government-owned tooling.

KOLLSMAN ACQUIRES: Kollsman Instrument Corp. will operate Richardson-Allen Corp., College Point, L.I., as a wholly-owned subsidiary to manufacture silicon rectifiers and transformers. Kollsman is a Standard Coil Products Co., Inc. subsidiary.

CABLE FIRM ORGANIZED: Phelps Dodge Corp., Northrop Corp., Page Communications Engineers, Inc., (Northrop subsidiary), and Felten and Guilleaume of West Germany have jointly formed the United States Underseas Cable Corp. to design and construct long-distance underwater cable systems. The company has no plans to operate as a common carrier.

DYNA-MATICS INC. FORMED: Making headquarters in Sun Valley, Calif. the firm will manufacture control equipment, valves, regulators, turbine flow meters and pumps for aircraft, missiles and ground support systems.

Dyna-Matics president is J. H. Overholser, former VP-sales and engineering and director of Poly Industries, Inc., as well as president and founder of Hydrodyne, Inc. Executive vice president is E. H. Haag, previously a partner in Air Products Co., and general manager, Bruce Engineering Corp.

R&D ORGANIZATION STARTED: The Princeton Chemical Research Co., a contract research and development organization specializing in petrochemicals, polyolefins, and catalysis, began operating in Princeton, N.J. March 1.

$1-MILLION R&D LAB OPENS: Electro-Optical Systems, Inc.'s $1-million research and development laboratory in Pasadena is now complete and will work on the development of an ion engine, molecular electronics, exploding wire techniques, optical homing and guidance systems, high-speed switching techniques, solid-state transducer development and space defense systems.

WESTINGHOUSE EXPANDS: Joining other firms in the R&D race, Westinghouse is breaking ground for a new center. Two new buildings in Churchill Borough, Pittsburgh, will house materials, new products, manufacturing and controls laboratories and patent department.

LFE OPENS DIVISION: Laboratory For Electronics, Boston, is opening an Advanced Development Division for research and development of advanced communications systems and techniques, navigation of space vehicles, reliability and data retrieval and recognition.

SPACE PACKAGES OFFERED: Space Instrumentation Division of Acton Laboratories, Inc. has been created to engage in research, development and fabrication of packaged rocket and satellite precision instrumentation. Technology Instrument Corp. is Acton's parent company.

financial news

THE MARTIN CO.—Completing its transition from manufacturer of military aircraft to modern weapons systems, it reports a sales increase for the ninth consecutive year.

Sales in 1959 were $523.7 million, compared to $483.6 million in 1958. This marked an 8% rise. Backlog at end of 1959 totaled $900.5 million, compared to $831.5 at the end of 1958.

A substantial rise in net income was also realized, with 1959's income $13.3 million topping that of the previous year by 13%.

• **Burroughs Corporation**—Revenue from the sale of military products reached a record high in 1959, accounting for about 27% of total revenue. Net income for 1959 totaled $7.1 million compared to $6.4 million in 1958.

Bell To Build French Birds

BELL AIRCRAFT is moving into the missile target drone business. The company has signed an agreement with Nord Aviation of France for U.S. manufacturing rights to the *CT-41* Mach 2.5 radio-controlled drone (above) and the subsonic *CT-20* target missile. The *CT-41* is launched by two solid-propellant boosters and powered in flight by twin ramjets. It is 32 ft. 2 in. long, 20 in. at its largest fuselage diameter and has an 11-ft. 11-in. wing span. Speed ranges up to 1650 mph at altitudes of more than 70,000 ft. Bell says it is "actively exploring" possible interest in the two missiles by the Army, AF and Navy.

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reviews

LETTER SYMBOLS FOR ROCKET PROPULSION, ASA Y10.14-1959, American Standards Association, 70 East 45th St., N.Y., N.Y. $1.50.

A one-volume collection of all the symbols for terms and concepts frequently used in the design, manufacture and operation of rockets. Where more than one symbol is in common usage, the standard designates one as the preferred symbol but includes the others as alternates.

THE EFFECT OF RAPID LIQUID-PHASE REACTIONS ON INJECTOR DESIGN AND COMBUSTION IN ROCKET MOTORS. Gerard W. Elverum Jr., and Peter Staudhammer, Jet Propulsion Laboratory, California Institute of Technology. Order N-79234, JPL from NASA Technical Information Division, Code BID, Washington 25, D.C.

Data are presented indicating rates and magnitudes of energy released by the liquid-phase reactions of various propellant combustions.

The data show that this energy release can contribute significantly and thus aid the combustion process. Color photographs of open flames using various injector elements are given.

HIGH-TEMPERATURE INSULATION FOR WIRE (part 2), J. N. Harris and J. D. Walton, Georgia Institute of Technology. Order PB 151944 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 40 pp. $1.25.

This report covers the second year of a research project aimed at development of efficient insulation for electrical wire to be used at temperatures of −85° to 1500°F.

Performance standards require that the insulated wire be as light in weight as possible and flexible at room temperature for ready installation.

Tests indicated that colloidal silica impregnation may be an improvement over silicone resins for sealing anodized aluminum wire.

AIRCRAFT AND MISSILE DESIGN AND MAINTENANCE HANDBOOK, Charles A. Overbey. The Macmillan Company, New York. 369 pp. $9.75.

The handbook contains over 160 tables and 40 figures to illustrate the standard methods of equipment installation and maintenance.

The text explains the standards and gives hundreds of tips on the proper handling of materials and tools.

Topics covered are electrical and plumbing systems, materials of construction, aircraft and missile hardware, color codes and conversion systems, and processes such as metal spraying, anodizing, rust-proofing, plating, welding, and brazing.

HIGH-TEMPERATURE ELECTRICAL INSULATING INORGANIC COATINGS ON WIRE (part 2), C. G. Bergeron and others, University of Illinois for WADC. Order PB 151943 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 55 pp. $1.50.

The report covers the second year of research on a project to develop effective wire insulation able to withstand temperatures to 1500°F. Tests included flow-coating 0.020-in. copper wire in continuous motion through a ceramic slip.

The researchers found that oxidation of copper into the coat was actually desirable for better electric conduction at high temperatures.

Tests indicated 0.1 mils or less to be the desired thickness of a coat. Yet the cracks formed in testing a thicker layer did not reduce insulation strength.

ULTRAHIGH TEMPERATURE (500° C) POWER TRANSFORMERS AND INDUCTORS, H. B. Harms and J. C. Fraser, GE for WADC. Order PB 161046 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 576 pp. $7.

The report covers the second phase of research aimed at production of lighter, more compact and efficient electronic power transformers to operate in an environment of 500° C plus the heat induced in them by intense radiation.

Much of this phase of the research project was concerned with hermetically sealing a transformer. It was found that contouring the hermetic to the core and coil saved considerable size and weight.

A very thin ceramic film insulation of nickel-clad copper wire was developed. The discovery proved to be an important additional contribution to research on ultrahigh-temperature magnet wires.

TECHNICAL RESOURCES DIRECTORY-MISSILE GROUND SUPPORT EQUIPMENT, Office of the Director of Defense, Research and Engineering. Order PB 161103 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. $.50.

The directory, divided into Army, Navy, and Air Force sections, lists various components, such as "axles and differentials," "bearings-ball and roller," and "bodies-truck and trailer," then lists the agency and the name of the individual within the agency who has cognizance over the item.

DESIGN INFORMATION ON 5CR ALLOY STEELS FOR AIRCRAFT AND MISSILES, F. R. Morral, R. J. Favor, and W. P. Achbach. Order PB 151072 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. $1.25.

The 5-Cr-Mo-V (H-11 type) steels are characterized by a high-strength/density ratio in the 1000° F range, sufficient harden-ability to permit air quenching, and tempering temperatures of 1000° to 1100° F.

They also have slightly less tendency to scale in air and better thermal shock resistance than low-alloy steels. These characteristics make them promising for many uses in aircraft and missiles.

THE ALL-BETA TITANIUM ALLOY (TI-13V-11CR-3AI), R. A. Wood and H. R. Ogden. Order PB 151066 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 199 pp. $3.

Technical information on an all-beta titanium alloy is summarized.

The alloy is a relatively new type containing 25% alloying ingredients. These additions to the titanium base produce an alloy with a very sluggish beta-phase decomposition.

editorial . . .

Space Goal—A Nuclear Moon Rocket

A forthcoming report on hearings held by the Joint Committee on Atomic Energy this past week can have a great effect on the nation's space program and whether we permit the Russians to gain an insurmountable lead.

At stake, among other things, is Project *Rover*—a nuclear propulsion system capable of carrying a manned expedition to the moon and return; conceivably the same system or its successor could carry men to Mars and Venus.

Conceivably also, Project *Rover* could accomplish the manned moon expedition within 10 years if it were supported and pushed. While there are other possibilities—the clustered *Nova,* for instance—most space scientists in the country today feel that nuclear power represents the only really feasible method of lifting the enormous weight a moon expedition would require.

A strong report from Senator Clinton Anderson's committee could lift *Rover* from the limbo where it has resided for five years and give the United States a major goal in space—a goal it completely and sadly lacks now.

Rover began in 1955 as a joint AEC-Air Force project with a 1960 target date for ground tests on the engine. The project was downgraded in 1957 and stretched out again last winter when the President moved the ground feasibility test date to 1964. Its budget diet has been one barely sufficient to sustain life.

When NASA was formed the project was transferred there from the Air Force. NASA now is responsible for the non-nuclear components of Project *Rover* and has in effect subcontracted the nuclear portion to the AEC. Industry has a few small related contracts.

As of the moment, the project stands about like this:

The AEC wants a high-gear program with a goal of a manned expedition to the moon (20,000 pounds payload) in 10 years or less.

NASA, which did not even include *Rover* in its 10-year space program published recently, favors a cautious approach—full speed on ground testing, but not so full for flight testing.

The Administration, or Bureau of the Budget if you like, wants a further slowdown, cut the 1961 AEC budget allocation for *Rover* and forced AEC to substitute other funds to keep it alive.

There are other differences, too, between AEC and the NASA, but they are mainly technical and apply to testing methods.

Sen. Anderson tends to side with the AEC. Even further, he has suggested the industry-service approach which produced the atomic-powered submarine. The Senator wants some action and is seeking a way to get it.

Some things appear self-evident in our pat-a-cake space program. One of them is that we desperately need a national goal in space toward which the bulk of our efforts could be directed.

In the thinking of most space scientists, that goal should be a manned expedition to the moon.

With that as a goal, all other space exploration projects fall into place. Communications, reconnaissance, space platform laboratories, space rendezvous and refueling, and human factors all assume their proper perspective as supporting elements of such a goal.

Senator Anderson and his committee cannot directly force fast and purposeful action on a nuclear rocket which could place an American team on the moon in reasonable competition with the Russians—but they can, and we hope will, direct enough public attention to the project to make such action imperative.

Clarke Newlon

STEPS IN THE RACE TO OUTER SPACE

Escape In Space

The space-assembled super satellites of the future will periodically encounter disaster—collision, mechanical failure, military attack, or the long chance of being hit by a meteorite. When this happens, "life boats" like the one shown here will bring their crews safely back to earth.

Here is the operational sequence of an escape in space:

1. Crew members don pressure suits and strap themselves into decelleration beds within the pressure-intact unit.

2. At the "Abandon Ship" signal, low-power, RATO-type launching rockets blast the sealed capsule from the threatened station (upper right illustration).

3. Acting on orders from an astrogational computer, the retro-rockets check the capsule's speed and break it out of orbit. (Foreground. Note details of offset heat shielding, hatches, slow-down parachute covers.)

4. As the capsule enters the outer atmosphere, the heat shield protects the astronauts. The life boat's momentum slows even further, and the shield is jettisoned as it cools.

5. Four parachutes are released, acting as air brakes. After a computed interval, other chutes are released.

6. The capsule lands in a predetermined sea rescue area, and a ring oı flotation bags inflate. A radio broadcasts the craft's location, and a bright sunshade serves as a visual and radar target for rescuers.

ARMA, now providing the inertial guidance system for the ATLAS ICBM and engaged in advanced research and development, is in the vanguard of the race to outer space. For this effort, ***ARMA*** needs scientists and engineers experienced in astronautics. ***ARMA***, Garden City, New York. A Division of American Bosch Arma Corporation.

AMERICAN BOSCH ARMA CORPORATION

April 4, 1960

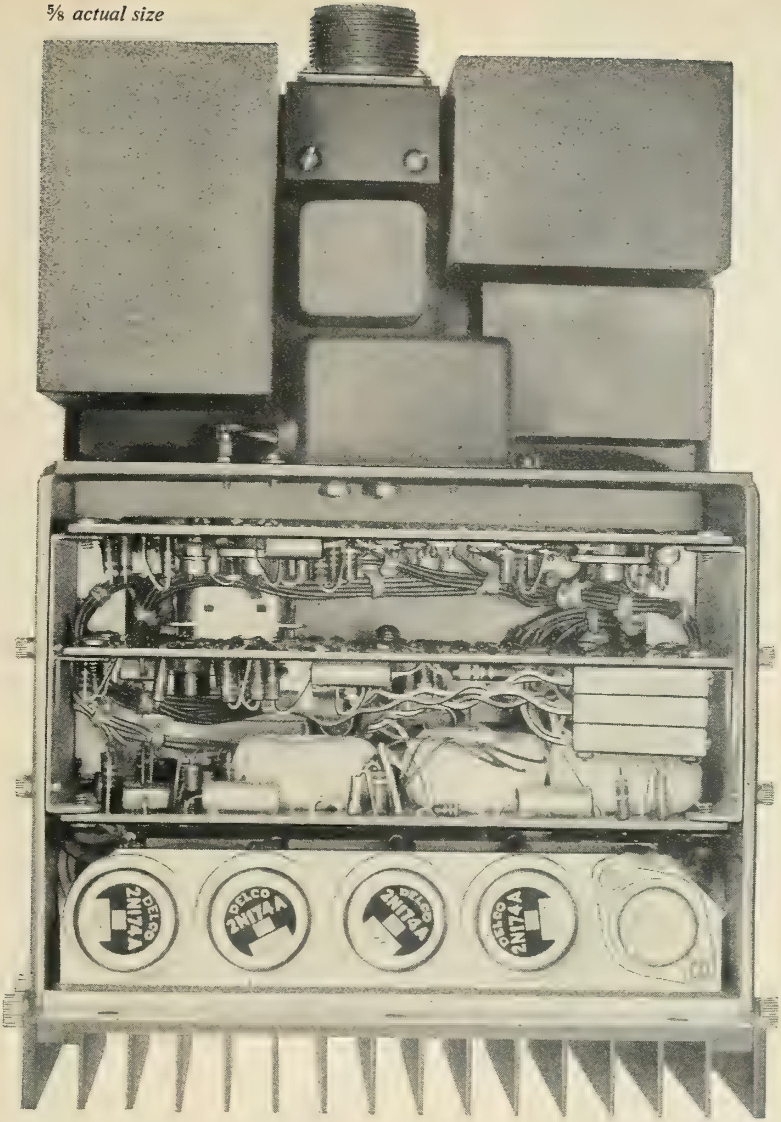
missiles and rockets

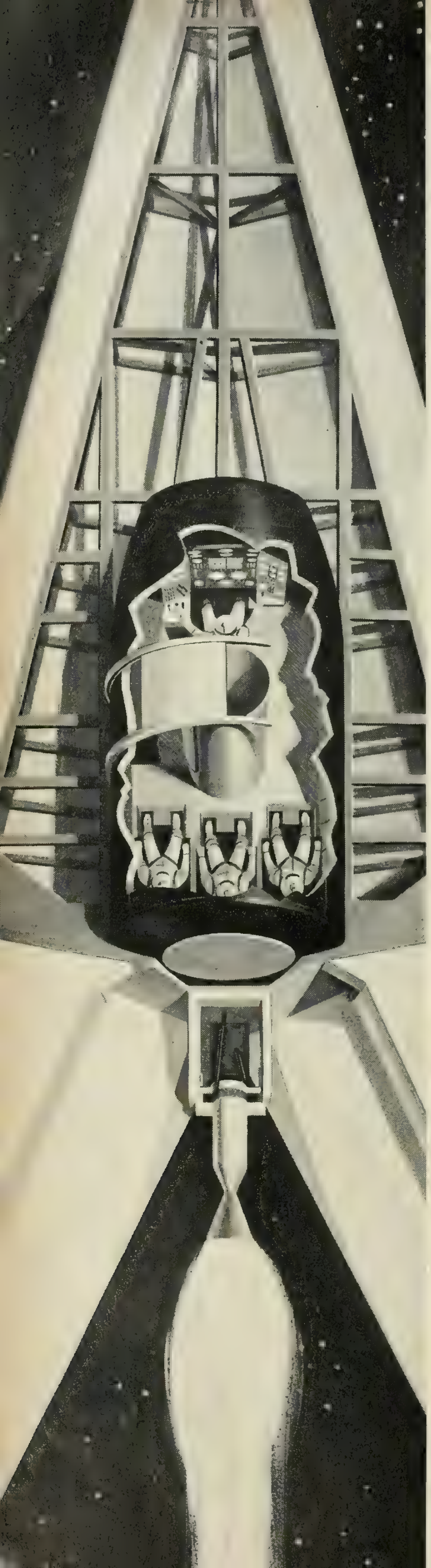
THE MISSILE/SPACE WEEKLY

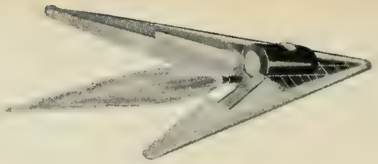
Avco's RVX-4 Nose Cone Rides on *Atlas*

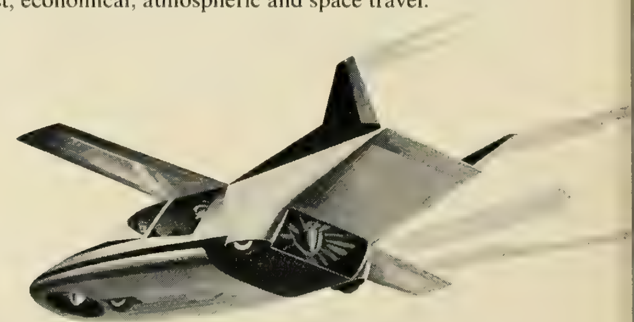
AN AMERICAN AVIATION PUBLICATION

⅝ actual size









THE MISSILE / SPACE WEEKLY

missiles and rockets

April 4, 1960 Volume 6 No. 13

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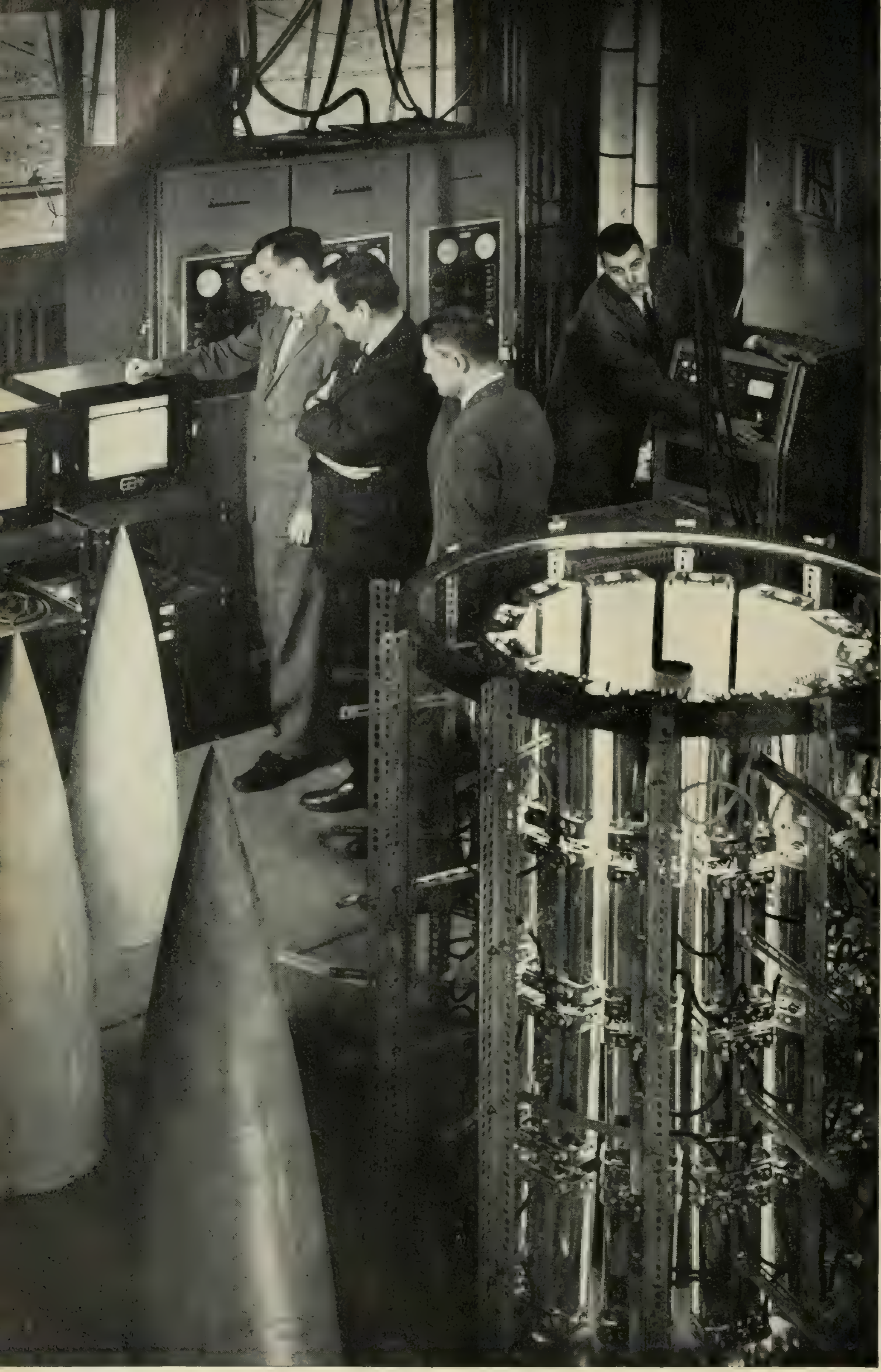
THE COVER

Avco's RVX-4 nose cone crowns an Atlas on launcher at Cape Canaveral. For a report on progress in Air Force nose cones, *see p. 32.*

29,900 copies this issue



"MISSILES AND ROCKETS magazine is particularly valuable to us as it helps anticipate new and future trends through its concise technical news coverage." Fred R. Youngren, Manager, Raytheon's Aeromechanical Branch. In the picture above, Mr. Youngren (left) explains to Hal Gettings (center) of the editorial staff of Missiles and Rockets, the Raytheon thermal shock test process for ceramic radomes. It is through tests such as these that improved radomes have been produced to meet the requirements and conditions demanded by higher and faster missile flight.

WHO

Clark C. Abt (left), Manager of Raytheon's Advanced System Studies Section and a regular reader of Missiles and Rockets magazine, discusses some of the problems of anti-ballistic missile defense with M/R Editor Hal Gettings. This particular section of Raytheon is working on the design and analysis of systems to detect, track and intercept threatening vehicles from sea, the atmosphere and space. This program is a natural outgrowth of Raytheon's extensive studies of air defense by means of surface-to-air and air-to-air guided missile systems.

"Even when a component is developed to a fine point, there is still a problem of extending the *state of the art*. The weekly issues of Missiles and Rockets keep us posted on the latest achievements of other companies in the missile/space field." Bertrand E. Chatel (left), Gyro Section Manager.

(above right) "High power output in a small reliable package is a basic requirement for electrical power units. Missiles and Rockets continually provides us information in related areas of engineering." John V. Kelly (left), Head of the Engineering and Mechanical Design Section.

READS MISSILES AND ROCKETS?

Well, for example . . .

TOP ENGINEERS AT RAYTHEON

Raytheon's Missile Systems Division has achieved outstanding success in pioneering and producing major missile systems. Two of these have been for the U. S. Navy air-to-air Sparrow III and the U. S. Army ground-to-air Hawk. These achievements, conclusive proof of unlimited capabilities, received their chief impetus when a Raytheon-developed guidance system installed in the Navy's experimental Lark achieved history's first successful interception in 1950 and first destruction of an airplane by a guided missile in 1951.

Much of Raytheon's success in guided missile systems since 1944 is credited to the tight integration of systems and component engineers. Close liaison of these groups provides systems engineers with rapid assessment of potential advances in "state of the art" of components and circuits, and also gives component engineers early indication of future requirements for meeting the needs of new, more complex missile and space systems.

Raytheon's Gnat gyros, for example, were first in the field, have been continuously refined, and now are mass-produced. Thermal effects of ever higher supersonic speeds are continuously being met by newly developed ceramic radomes—the largest being 4 feet long, 15 inches in diameter, and weighing 90 lbs. Highly reliable Electrical Power Units (EPU's) have been compacted into the smallest of spaces.

The further ability to carry these and other developments through flight test and into quantity production has resulted in the present top performance and high reliability for Raytheon's Hawk and Sparrow III missiles.

Experience of accomplishments in the broad field of missile and space sciences has promulgated study and development programs in solar energy conversion, ion propulsion, very-long-range ICBM tracking and identification radar, infrared missile applications and range instrumentation systems. Parallel advances also have followed logically, with studies of AICBM systems and investigation of means for defense against satellites.

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missiles and rockets

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the
missile
week

Washington Countdown

IN THE PENTAGON

The second *Transit* . . .

navigation test satellite is now scheduled to be launched about mid-April. The launching originally was planned for February, but it was postponed because no booster was made available.

• • •

The new *Thor-Delta Star* . . .

booster under development by the Air Force will be used to boost *Transit No. 2*. Meantime, a *Transit* transmitter will be included in the next *Discoverer* satellite launching. That will be *Discoverer XI*.

• • •

Minuteman experts fear . . .

that East-West negotiations on a nuclear test ban may prevent them from ever increasing the power of the *Minuteman's* nuclear warhead. They feel further testing would make possible a more powerful warhead—closer to the size of the *Atlas* warhead.

• • •

Tank tracks for *Mauler* . . .

are planned by the Army. Plans call for carrying the new Convair missile on the AMF's new 113-tracked chassis. Eventually, the Army wants to carry other missiles on it also.

• • •

Dyna-Soar's master blueprint . . .

is expected to be laid down by the current Air Force study of the planned space bomber. The blueprint will cover all three planned stages ranging from glider tests through ballistic flights to the operational spacecraft.

• • •

A Navy communications satellite . . .

is being worked on. It will weigh about 50 pounds and will be launched into an orbit ranging between 400 and 600 miles from the earth.

• • •

Designing two missiles in one . . .

is under consideration by the Army. Some Army missilemen want to combine the proposed *Missile A*, a direct battle support missile, and the proposed *Missile B*, an indirect battle support missile, into one bird.

ON CAPITOL HILL

Moneyman for Symington . . .

presidential campaign will be Oklahoman Hal Stewart, who was an assistant AF secretary when Symington was boss of the Air Force. Lots of big oil and defense industry tie-in here. Ed Hogan, former Air Force Association publicist now with GE's Evandale group, has been offered an important spot in the Symington publicity setup.

• • •

Life-long Republicans . . .

in the defense industry will give money, support and votes to Symington. Reason: dissatisfaction with the present defense-space program and budget.

AT NASA

Project *Mercury Redstones* . . .

will use *Jupiter-C* tankage in order to increase their burning time.

• • •

High hopes . . .

are held out for Project *Ranger*, an attempt to rough land intact an operating instrument package on the moon in 1961.

• • •

Wallops Island's . . .

causeway from the mainland has been completed but not surfaced. Light vehicles can presently make the trip.

• • •

Centaur . . .

may be ready sooner than expected. Original launching date was the summer of 1961, but insiders now say that the liquid hydrogen-LOX stage may be completed by March, 1961.

INTERNATIONAL

More Red missile bases . . .

are reported under construction in the rugged Albanian countryside. The Soviet Union is reported to have missile bases ready at Valona, Skutari and Durazzo, from which to strike at Italy.

• • •

Japanese missile experts . . .

will tour the United States and Western Europe within the next two months. The 14-member delegation is headed by the Mitsubishi Electric Co.

DOPLOC Already Operating

To the Editor:

Your article in the March 7 issue has come to our attention.

To clarify the Army DOPLOC position in the dark satellite fence would require considerable space. However, in essence, the DOPLOC system presently in the field is even now furnishing data on satellite "strikes" to the proper agencies. It might be pointed out along these lines that the unknown satellite you mentioned was detected by DOPLOC and reported in early October to the proper agencies.

Realizing that the problem of acquiring unknown targets such as dark satellites is an extremely difficult problem with conventional searching "pencil" antenna beams, the Ballistic Research Laboratories as an interim measure adopted the concept of the fence much as you described in your article. In such a system, the satellite flies through the fixed "fence" antenna beam yielding one bit of information. This concept furnishes limited information for calculating of orbit on one satellite pass.

While still operating a "fence" type of DOPLOC system as an interim measure, the Ballistic Research Laboratories have conceived a more sophisticated system. This proposed system has been submitted to higher authority for approval. This system will allow rapid calculation of orbit on one satellite pass. Use of the Doppler rather than conventional ranging techniques assures the extremely high precision required in orbit determination.

James P. Hamill
Colonel, OrdCorps
Director
U.S. Army Ordnance Ballistic Research Laboratories
Aberdeen Proving Ground
Maryland

Packard Bell's ATE Work

To the Editor:

Your article, "Automatic Test Equipment Burgeons" (M/R, Feb. 29), is a good one, and I am sure it has brought many people up to date on the current status of automatic test equipment.

I would like to point out, however, that you have slighted Packard Bell in your chart designated Missile Systems and Test Equipment. Packard Bell has been a major subcontractor to Douglas Aircraft on the *Thor* project and some $23 million worth of automatic test equipment was delivered under this contract.

Other missile programs that we have worked on include: *Falcon*—$1 million ATE; *Snark*—$.5 million ATE, *Talos*—$1.5 million ATE; on *Polaris*, we received our fair credit.

Jack D. Behr
Director of Advertising and Public Relations
Defense and Industrial Group
Packard Bell Electronics
12333 W. Olympic Blvd.
Los Angeles 64, Calif.

How *Saturn* Arrived

To the Editor:

Congratulations for a very fine piece of friendly reporting on the *Saturn* and the *Saturn* team.

It might be of interest to your readers to correct two items, just to keep the record straight. Preliminary design studies on a 1.5 mill. thrust booster were started at ABMA as early as April, 1957; however, they were based on using four E-1 engines from Rocketdyne at 330K each, an advanced engine at that time under development. These design studies as well as the fact that our test tower with some modification could handle such a booster were brought to the attention of ARPA in July, 1958.

It was R. Canright and D. Young of ARPA who then suggested to use eight *Jupiter* engines instead of the four E-1 engines in order to save some $50 million engine development money which just was not available. They deserve the credit that the *Saturn* finally was approved by ARPA and funded by the amount of $10 million to demonstrate the feasibility of a multi-engine cluster. Thus it was not us who suggested an eight-engine cluster; ours was a four-engine cluster but with the same thrust level.

H. H. Koelle
Chief, Future Projects Design Branch
Army Ballistic Missile Agency
Huntsville, Ala.

Army's Fuel Cell Report

To the Editor:

I have been enjoying your magazine for some time and noticed in the 14 March issue that you have some information on fuel cells.

I would very much appreciate receiving a copy of Report Number 1, Status Report on Fuel Cells by the Army Research Office. If you do not have this report, I would appreciate knowing where I could receive one.

R. J. Boyle
Senior Marketing Analyst
Military Products Group
Minneapolis-Honeywell
Regulator Company

In answer to this and numerous other inquiries, the report entitled "Status Report on Fuel Cells," by B. R. Stein, ARO Report No. 1, June 1959, is available from Army Research Office, Office of the Chief of R&D, Dept. of the Army, Washington 25, D. C.—Ed.

Industry Countdown

MANUFACTURING

Another delay . . .

is reported in Project 3059, the proposed Air Force solid-propellant booster with 100 million lb.-seconds total impulse. Although the word until last week was that Aerojet-General would win the contract, competing companies feel the battle is not lost. Thiokol, in particular, feels that the big booster can be its biggest challenge in this decade.

• • •

Minuteman will measure . . .

just under 60 ft. long, according to Capt. Frank H. King of BMD. Fully armed missile will weigh 60,000 to 70,000 lbs., less than *Thor* and about ¼ as much as *Titan* or *Atlas*. Four-nozzle system will permit control of pitch, yaw and roll. Third-stage power will cut off before burnout if desired.

• • •

NASA will select . . .

a contractor this month for Project *Sunflower*, a 3 KW solar power system for use in *Centaur* and *Saturn* space vehicles. *Sunflower* consists of a solar collector that focuses heat on a boiler that vaporizes liquid metal to drive a turbo generator. The competition drew 23 bidders.

• • •

World War II rockets . . .

are being used to cut the cost of *Bullpup* air-to-surface trainer missiles produced by Martin. Under a $700,000 AF contract, Martin is building trainers with obsolete HVAR motors weighing only 125 lbs., about ⅕ as much as operational *Bullpups*, but with the same aerodynamic characteristics.

PROPULSION

Saturn cluster concept . . .

underwent successful first static test March 28 at ABMA. Two Rocketdyne H-1 engines, each generating full 188,000 lbs. thrust, were fired in tandem for a little less than 30 seconds. Resonance was within safe limits and, with the new 30,000-gallon-per-minute water spray in operation, noise was less than in a *Jupiter* test. Results were telemetered on 300 channels.

Tests of four engines, six engines and the full eight-engine cluster are planned in rapid sequence, probably within the month. NASA Administrator T. Keith Glennan told the Senate Space Committee the *Saturn* booster will be flight tested with dummy upper stages in summer of 1961.

• • •

Long production run . . .

of engines for the Army's liquid-propellant *Corporal* is about to end at Ryan Aeronautical with the changeover to the solid-propellant *Sergeant*. Ryan has produced "many hundreds" of *Corporal* engines since production began in 1951. New project at Ryan: cases for the Grand Central *Viper* a small solid motor used to propel research sleds.

ELECTRONICS

Super-accurate data . . .

transmission system has been installed at Atlantic Missile Range. The automatic system, which RCA calls CODIT (Computer Direct to Telegraph) is used to transmit computed trajectory data from Cape Canaveral to downrange radars in a few seconds.

• • •

Navy has almost completed . . .

work on Project *Artemis*, a study to establish the feasibility of ocean area antisubmarine surveillance. Meanwhile, Douglas Aircraft's El Segundo Division reports development of an electronic system for detection and analysis of underwater sound.

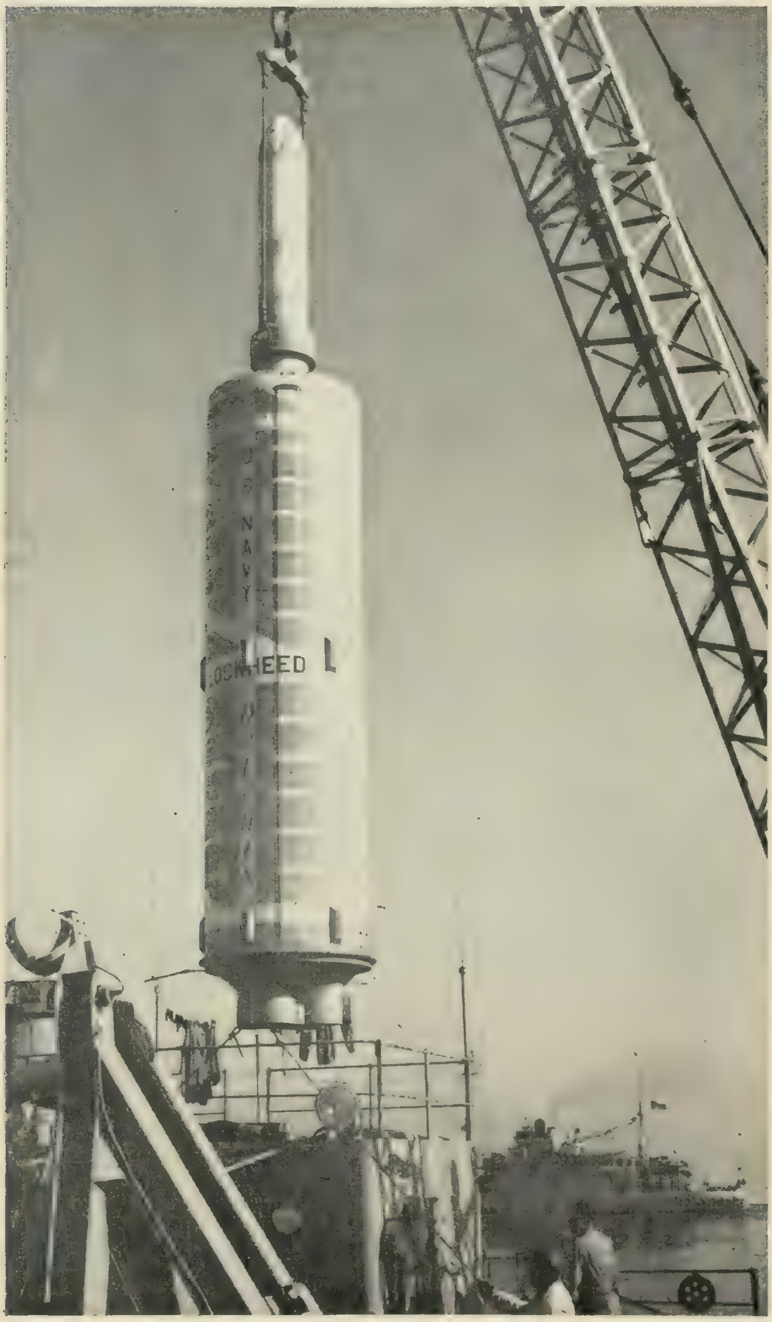
WE HEAR THAT

Britain has curtailed . . .

work on the *Blue Streak* IRBM, while the government reappraises its whole defense policy . . . Russia is building airport facilities for jet cargo carriers big enough to handle large rockets at the major launching sites in Irkutsk at Alma-Ata, and at Khabarovsk, near the rail line to the Komsomolsk missile base . . . The Navy has deployed two more *Bullpup* squadrons to the Far East, aboard the USS Ranger in the Seventh Fleet.

Navy Opens *Polaris* Assembl

By James Baar



DUMMY OPERATIONAL ***Polaris,*** **dubbed the** ***Dolphin*** **is designed for training submarine missilemen and testing equipment aboard** ***Polaris*** **submarines.**

CHARLESTON, S.C.—The Navy's *Polaris* program last week moved several major jumps forward toward the time later this year when the first operational missiles are scheduled to go to sea.

The Navy officially opened its $27-million *Polaris* Assembly Depot some seven miles up the Cooper River from this old Southern city. From here all *Polaris*-launching submarines will take on their operational 1200-mile-range missiles before going on station somewhere in the world's oceans.

Meantime:

• Some 14 miles off Cape Canaveral on the evening of March 29 an all-but-operational Lockheed *Polaris* roared for the first time from the surface test ship Observation Island and impacted more than 900 miles down the Atlantic Missile Range. The *Polaris* system's operational navigation, fire control, launching and guidance systems were integrated for a firing for the first time. The Navy said all test objectives were achieved.

• In Washington the Navy announced it would pump another $52 million into the *Polaris* program to speed up work on seven *Polaris* submarines now under construction. The money is not connected with Navy Proposals to add more nuclear-powered *Polaris* submarines to its Fiscal Year 1961 budget.

• Somewhere in the Atlantic the nuclear-powered George Washington, first of the *Polaris* submarines, was reported to be launching Lockheed *Dolphins,* the new dummy operational *Polarises* designed for training and testing equipment.

• Rear Adm. William F. Raborn, head of the *Polaris* program, told newsmen that a 2500-mile-range *Polaris* could be developed by the end of 1963 if enough funds were provided.

• **Minor setback**—The only setback of the week for the *Polaris* program turned out to be a random accident.

Off San Clemente Island, Calif., the first "hot" firing of a *Polaris* from a submerged launching tube failed because of faulty wiring in the blockhouse. The 28-foot cut-grain test missile successfully "popped" from the tube but failed to ignite because its internal power had been cut off automatically seconds before the launching

acility

Officials called the setback minor. They said the wiring was not part of the operational system.

• **Producer-to-sub**—The new 880-acre *Polaris* Assembly Depot—called the Navy Weapons Annex—will be the link between the industrial team producing *Polaris* and the *Polaris* submarines.

The missile components will be flown to the Annex and stored. Warheads and motors will be kept in special underground magazines.

A series of specialized buildings have been constructed to check out and service the missile's components before they are assembled into an operational weapon ready to be placed aboard a submarine.

Missiles that already have been to sea will be brought back here for periodic major checkouts and overhauling. All *Polaris* submarines returning from station for overhauling will first unload their missiles at the Annex.

• **Specialized buildings**—One of the largest of the Annex's buildings is the 24,300-square foot Inert Processing Building. This will be used for checking and repairing guidance systems, hydraulic systems and various electronic devices.

A 5400-square foot Motor Inspection Building will be equipped to employ bore-scope, X-ray and ultrasonic methods for checking motors for possible damage in transit from the West Coast.

Smallest of the buildings is a 3300-square foot Re-Entry Body Assembly Building, where the warheads will be readied for emplacement in the missiles. The building, with its rows of consoles, operating tables and little carts, has the air of a hospital.

The Annex has two other large buildings for housing equipment for the upkeep of support facilities and for storing the wide variety of shipping and handling containers used for the assembled missiles and the missiles' separate components. An Engineering Services Building is planned, and construction will begin in the near future.

Final putting together of the missile will take place in a 1500-square foot Missile Assembly Building, where three assembly lines can operate simultaneously. Once assembled, the missiles will first be placed in metal "liners" that will guard them against shocks and adverse temperatures. The liners, in turn, will be inserted into wheeled containers for handling.

• **Tricky loading**—The protected birds will be hauled on railroad flatcars to a new 1000-foot pier about three miles away on the Cooper River. Here a $551,000 crane will carefully load the missiles either into the tubes of a waiting submarine or into the hold of a submarine tender.

In loading a missile, the entire container will be swung over a missile tube and the missile will be lowered into the tube by equipment inside the container itself.

Four miles of the Cooper River were dredged by the Army Corps of Engineers so that both *Polaris* submarines and tenders could have access to the area. The dredging cost $441,000.

The first of the *Polaris* tenders—the Proteus—will be a converted merchantman. The conversion work is being done at Newport News, Va.; the ship is expected to join the fleet this summer.

The Proteus will secretly rendezvous with the *Polaris* submarines at sea and provide them with various services, including the replacement of missiles in need of major work. The ship can handle about 20 missiles.

• **Navy industry staff**—More than 200 Navy officers and men will operate the Annex. They will be assisted by about 125 engineers from Lockheed, the missile's prime contractor; 15 from General Electric, developer of the *Polaris* guidance and fire control systems; and five from Aerojet-General, developer of the missile's big solid motors.

The buildings are laid out in a semicircle fronting the rows of widely spaced magazines. The entire area is surrounded by a high steel fence topped with barbed wire. Marine guards patrol it.

The isolated area in South Carolina's coastal back country was once a large plantation called Liberty Hall. The new buildings are now surrounded by newly bulldozed earth. But not far away Spanish moss clings to the live oaks, like ghosts of the Southern past.

The site was chosen because of a number of geographical and economic factors.

The area has a moderate climate and is an ice-free port throughout the year. It is protected, yet has easy access to the sea. And it is near a sizeable Navy yard at Charleston, which some of the *Polaris* fleet will use as a home port.

The existence of ammunition magazines and other facilities in the area, particularly the Charleston Ammunition Depot, enabled the Navy to cut overall construction costs.

Commissioning ceremonies took place on March 29—two days before the Annex opened. A large delegation of top Navy officials, including Adm. Raborn and Assistant Navy Secretary C. P. Milne, were on hand.

Milne called the Annex "the keystone" in the *Polaris* program.

Rep. L. Mendel Rivers (D-S.C.) proudly underlined the significance of the Annex more pointedly.

"Today Charleston becomes the potent thorn in the side of the Soviet Union," Rivers declared. "Today Charleston becomes the deterrent capital of the world.

"We also will make an indelible mark on the planning maps of the Soviet Union. This is the penalty we must pay for this great honor."

LAYOUT OF *Polaris* Depot, the Navy's new operational missile assembly facility near Charleston, S.C., is shown in an architect's drawing. The buildings lying in the semicircle from left to right are: Missile Assembly Building, Equipment Building, Motor Processing Building, Re-entry Body Building, Container Building, Inert Processing Building. Not shown are the widely spaced rows of magazines where warheads and motors will be stored.

NASA Aims to Push *X-15* Past Mach 3

by William J. Coughlin

EDWARDS AIR FORCE BASE, CALIF.—The National Aeronautics and Space Administration plans to push its first *X-15* rocket craft to speeds above Mach 3 within the next six or seven flights. Record altitudes of more than 24 miles are planned within ten flights.

This was revealed here as NASA Chief Pilot Joseph A. Walker made the initial research flight in the North American Aviation aircraft on March 25, taking it to Mach 2 at an altitude of 50,000 feet.

Walker is the first pilot other than NAA's Scott Crossfield to fly the *X-15*. Seven previous *X-15* flights have been contractor demonstration tests limited to proving out the design.

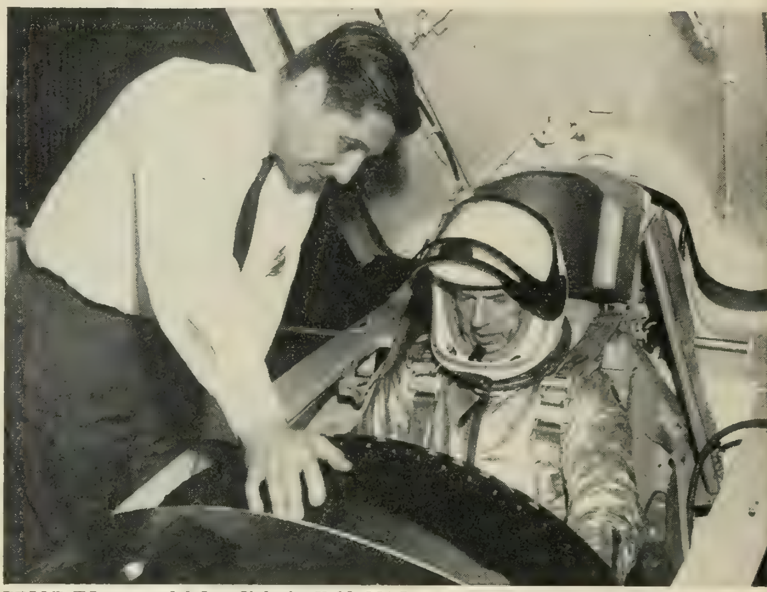
Meanwhile, the large XLR-99 rocket engine, capable of 50,000 lb. thrust and scheduled for installation in the third *X-15*, was delivered here last Monday (March 28) by Reaction Motors, Inc. The first North American *X-15* flight with the large engine is to be made in about six weeks, after Air Force inspection and test stand runups.

Walker made his flight in the No. 1 aircraft equipped with two interim XLR-11 rocket engines producing a total of about 16,000 lb. thrust. The aircraft was the first of the three *X-15's* to be turned over by North American to the joint NASA-Air Force-Navy program. Next flight in this aircraft will be made by Air Force Maj. Robert M. White, probably within the next two weeks.

Crossfield made the seventh powered flight in the No. 2 aircraft last Tuesday morning, a nine-minute flight to 50,000 feet and 1300 mph which included a negative 2g maneuver. Two powered flights have been made with the No. 1 craft and the No. 3 ship will not be flown until the XLR-99 engine is installed. NASA probably will receive this aircraft in late summer.

• **'Felt wonderful'**—Walker's initial flight was not preceded by glide flights. Obviously relieved after sweating out a three-day delay resulting first from weather and then from a broken LOX line, the NASA pilot emerged from the cockpit with a broad grin to announce that it "felt wonderful."

"The *X-15* seems to be a good extension of our knowledge from the previous X-aircraft," he said, adding that the rocket craft handled "just like the simulator."



PRIOR TO successful first flight in *X-15*, NASA Chief Pilot Joseph A. Walker is shown in simulator chatting with Scott Crossfield, his only predecessor as an *X-15* pilot.

Walker said the NASA program calls for pushing the *X-15* to speed limits of its flight envelope before altitude capabilities are explored. This is expected to take it far enough above Mach 3 to break the present speed record set by the X-2. Walker predicted the X-2 altitude record of 126,200 feet also will be exceeded. A high-speed research is being undertaken first since it makes possible a better check of handling characteristics than the altitude flights.

"How far we get over Mach 3 will be a function of how well we do on scavenging propellants and how much burning time we get," Walker said.

• **Normal landing**—On his initial flights, Walker explored sideslip, longitudinal and directional impulses in addition to familiarizing himself with the ship. After dropping from the B-52 mother ship at 45,000 feet, he climbed back to 50,000 feet and a Mach 2 speed before making a 2½-3g turn back to a normal landing on the dry lakebed.

Despite some slight difficulty in getting one of the upper barrels alight, Walker had all eight firing within a minute after drop. Total flight time was 11 minutes.

Walker said maximum altitudes with the No. 1 aircraft probably will be achieved within eight to 10 flights.

"The only target date we have is to shove along as hard as we can go and still be sure we know what we're doing," the NASA pilot said. Maj. White in his first flight will follow the same familiarization pattern. After that, the two pilots will alternate in stepping up the speed by increments.

Hardware has not yet been installed for the *X-15* reaction controls, although Walker twice has flown the test installation of reaction controls on a Lockheed F-104. This portion of the program still is in the development stage.

• **Oversensitive**—Walker disclosed that some material difficulties have been encountered with the storage bladders which contain the peroxide for the reaction system. He said the present system also has too high an increment of thrust above zero in its initial response, making it oversensitive.

The project has not yet reached the point where the F-104 has been flown while entirely dependent on the reaction controls.

During his *X-15* flight, Walker flew the craft entirely with the center stick, not employing the side stick. He said Crossfield also has switched to use of the center stick on all landings. North

American changed the response rate on the *X-15* tail after the initial landing by Crossfield got slightly out of phase.

In preparation for their own roles in the program, both Walker and White have flown chase on every Crossfield flight. They also have made numerous flights in the so-called "dirty" F-104 configuration to approximate *X-15* landing characteristics. In addition, the two men have attended the Crossfield debriefings and studied his flight reports.

"We three also have gotten together and just talked the thing over," Walker added. But he revealed that only two such talks have taken place.

• **Checks on Crossfield**—Under North American's contract with NASA, Crossfield has been limited to proving flights. There is little doubt the NAA pilot has been chafing under the restriction and this has led to some tension within the program.

Crossfield also will be restricted to low-speed and low-altitude runs with the No. 3 ship when it begins flying with the 50,000-lb.-thrust engine. This is a partially throttleable engine, with the first throttle opening producing about 30% of total thrust. To hold down performance, Crossfield presumably will be forced to employ his available rocket power only in bursts.

XLR-99 engines eventually will be installed in all three *X-15's*. With this engine, NASA expects to achieve speeds of well over Mach 6 as well as the design height of 50 miles or more.

• **100 miles . . . maybe**—D. E. Beeler, Assistant Director of the NASA Flight Research Center here, says the *X-15* "may hit the much-publicized 100-mile altitude mark, but we will have to wait until we get farther along in the program before we make any predictions." The *X-15* is designed to withstand re-entry temperatures of 1200°F.

Research areas to be probed in the high-speed *X-15* program include zero-gravity pilot problems, re-entry maneuvers, structural heating and structural loads during re-entry. North American also has proposed advanced projects which would employ *Atlas* and *Saturn* boosters to put the *X-15* into orbit.

Other pilots scheduled to take part in the *X-15* program include Lt. Cmdr. Forrest S. Petersen, Navy; Capt. Robert A. Rushworth, Air Force; John B. McKay and Neil A. Armstrong, NASA.

Bomarc Money May Go For *Atlases*

Proposed slash in funding for Air defense missile would provide more ICBM's; some sense behind-scenes bargaining

The Air Force-proposed slash of $381.1 million from the Boeing *Bomarc-B* program in FY 1961 made clear more than anything else in recent weeks the nation's capability and need to increase its ICBM power in the face of the growing Soviet missile threat.

However, at the same time, it also demonstrated the dangers of borrowing from one big defense program to pay for another.

The Air Force proposals as outlined to the House Appropriations Subcommittee would result in these major changes:

• Reducing the total number of *Bomarc* squadrons from 12 to eight. Five of the approximately 30-bird squadrons would be 200-mile-range *Bomarc-A*'s; three would be the 400-mile-range *Bomarc-B*'s. Only $40.4 million would remain in the FY '61 budget for *Bomarc-B*.

• Increasing the size of six *Atlas* squadrons from nine to 12 missiles by the end of calendar 1962 at an initial cost of $136 million. Total cost including construction of the hardened sites will be $326 million.

• Improving the radar and firepower of the McDonnell F-101 B and the Convair F-102 and F-106 supersonic interceptors at a cost of $134 million. The jets would be armed with the new nuclear-tipped Hughes *GAR-11 Falcon*.

• Eliminating all eight planned hardened *Sage* interceptor control centers at a saving of an additional $274.2 million over FY 1960 and 1961. The nation now has 11 completed "soft" *Sage* centers and nine under construction.

The effect of the proposed cuts on the *Bomarc-B* program would be to cut off all production orders as of about April 1. However, R&D on the controversial air-breathing missile will continue in order to provide operational birds for the three planned remaining squadrons.

A Boeing spokesman said the effect of the cuts on his firm would be a reduction of the 10,500 employes directly connected with the program by 2700 before the end of the year. He said cuts in employees indirectly connected with the program "will be proportionate" and that more drastic cuts are expected across the board in 1962.

Other increases in programs with funds taken from *Bomarc* and *Sage* include $27.6 million for advancing the operational dates of the second and third BMEWS sites; $61 million for the *Discoverer, Midas* and *Samos* satellites; and $27 million for the Boeing *Minuteman*.

Air Force officials testified that the Defense Department has already approved the proposed cuts but has not acted so far on the proposed increases to be paid for with the savings.

Moreover, the Pentagon already has turned down several Air Force proposals to use more of the savings that would be available for *Minuteman*, space projects and MATS cargo planes.

• **Bucking Administration?**—The Air Force proposal to build more ICBM's and launchers within the next two years ran counter to some Administration arguments that missile production could not be speeded up. It also ran counter to Administration statements that no increase is needed.

The proposed cut in the *Bomarc-B* program appeared to run counter to arguments advanced by the Administration last year in drumming up support for its proposed "master air defense plan" which leaned heavily on both the *Bomarc-B* and the now-dead North American F-108 program.

Finally, it appeared to run counter to the Administration argument that the Mach 3 F-108 could be killed last year because the nation still had the *Bomarc-B*.

Some observers felt the Air Force move followed behind-the-scenes bargaining with the Administration.

The results would be that the Administration could slip a few more ICBM's into the defense program to offset political criticism in an election year and the demands for a much bigger build-up. At the same time, the Air Force would get at least some of the increases that it wanted while cutting a program that seemed doomed to be cut by Congress anyway.

Big Missiles Will Cost $22.9 Billion

Mahon Committee reveals price tags on U.S. programs—Congress shows concern over missile/space gap

by Clarke Newlon

The 941-page report of the House Subcommittee on Department of Defense Appropriations, Chairman George H. Mahon, (D-Tex.), was released this last week. Most revealing facts in the report's two-inch bulk were:

• Costs of our major missile programs.

• Surprising optimism as to the operational dates of these programs.

• Interservice and even Intraservice fighting for millions in funding.

• Continued congressional interest in beefing up our missile and space program.

Chief witnesses in the missile field were: Army, Lt. Gen. Robert W. Colglazier, Deputy Chief of Staff for Logistics; Navy, Vice Admiral John T. Hayward, Deputy Chief of Naval Operations, Development, and Rear Admiral W. F. Raborn, Director, Special Projects; Air Force. Lt. Gen. Mark E. Bradley, Jr., Deputy Chief of Staff, Materiel.

Comparable costs of the big ballistic missile program, potential back-bone of the U.S. deterrent force were:

Atlas, $5.4 billion for 13 squadrons of 10, or 130 ICBM's.

Titan, $5 billion for 14 squadrons of 10 or 140 ICBM's.

Polaris, $9.9 billion for 45 equipped submarines, 16 missiles each or a total of 720 IRBM's.

Minuteman, no overall cost given. 1961 budget $368.3 million. Estimated cost (in production) $1 million each; estimated production 2600. Therefore, a possible program cost of $2,600 million plus development costs.

Operational dates for the missiles were given as follows, all of them with a degree of optimism which is not privately held by many in and out of the military:

• *Atlas*, one-half squadron activated in 1959 and a classified number of additional squadrons to be activated in calendar 1960.

• *Titan*, first operational squadron to enter SAC inventory in June, 1961.

• *Polaris*, available for deployment in 1960.

• *Minuteman*, build-up of operational hard force to start in mid-1962, with mobile system some months behind.

Least careful in their attitudes toward interservice rivalry were the Navy witnesses. Admiral Hayward referred to the *Bomarc* as "that horrible word." (The *Bomarc* program has been cancelled, in effect.) Admiral Raborn repeatedly stressed the advantages of *Polaris* over *Minuteman*.

The Air Force revealed its own family troubles in testimony about the *Titan* and the hot debates as to whether or not the program should be cancelled in favor of *Atlas* and *Minuteman*. The Air Force also revealed—and were questioned sharply about it—that some $579 million had been added to the *Titan* program to beef up its storable fuel potential and its guidance system.

Congressmen repeatedly questioned witnesses as to the missile and space gaps, the advisability of adding additional money to programs, of increasing programs, of speeding up programs by overtime. Many times the committee members invited requests for a speed-up of the defense/space effort.

Highlights of the various missile programs follow:

ATLAS

Thirteen squadrons of 10 each are programed. First four will be in "soft" sites.

Three squadrons with all-inertial guidance are programed to go into sites hardened to 25 psi.

Six squadrons will be installed in silos hardened probably to 100 psi.

One half of the first squadron was activated in 1959. "Additional" squadrons are to be activated in 1960.

Cost of the *Atlas* is $1.9 million, broken down as follows: Air-frame, $1.1 million; Propulsion, $.4 million; Guidance, $.2 million; Re-entry vehicle, $.2 million.

Total cost of the *Atlas* program is estimated at $5,400 million.

Cost per squadron of ten is as follows: Soft configuration, $20.1 million; hardened to 20 psi, $23 million; hardened to 100 psi, also $23 million.

The proposed long-range flight of the Atlas, intended to counter propaganda value of the Soviet Pacific missile shot, has been cancelled or postponed because of the chance it might err in flight and strike another sovereign country, Gen. Ritland, USAF, revealed to the committee.

He said that while the flight—in the 9000-mile category—would clear all land masses by at least 50 miles, this was not considered a sufficient margin of safety.

Maintenance cost is estimated at $5.3 million per squadron per year (the *Atlas* on the stand at Vandenberg for four months was in a state of readiness 98% of the time). No overhaul is planned for the ICBM. There will simply be a replacement of parts—such as the engine package. Eighty percent of the maintenance will probably be on GSE.

The spare parts problem will be handled by electronic data processing machines to keep a constant record of inventory.

Weapon system support equipment lists (WSSEL) on tools to support each *Atlas* unit number 3131 items (against 1905 for *Thor*). The cost is $32 million (the B52 WSSEL contains 2500 items and cost 114 million).

TITAN

The first operational *Titan* squadron is programed to enter the SAC inventory in June, 1961. First launch will be in October, 1960.

The first *Titan* in-silo launch will be made late this year. All-inertial flight testing for in-silo squadrons will begin in 1961.

The *Titan* program includes funds requested for *Titan Dyna-Soar* boosters as part of the *Dyna-Soar* early flight test program.

First six *Titan* squadrons will have radio inertial guidance in-silo sites hardened to 100 psi. They will be lifted by elevators for surface launch.

The last eight squadrons will be hardened 100 psi with storable fuel, all-inertial guidance and will be launched from within the silo.

Distance between silos, as in the *Atlas*, dispersal program will be 7 miles. SAC personnel started training in May 1959. Construction of a silo launch test facility has begun.

Four squadron sites are under construction and/or checkout.

The six successful *Titan* flights (of the 9 attempted up to March 3, 1960) were as follows: 245 nautical miles, 256 nautical miles, 300 nautical miles, 2385 nautical miles, 5050 nautical miles and one unlisted. The first all-inertial guidance flight of *Titan-2* is scheduled for March, 1961.

Actual expenditures on the *Titan* program (in millions):

1959 and prior	$1,132.7
Fiscal 1960	615.2
Fiscal 1961 (est'd)	873
Total	$2,629.9

Total appropriation through fiscal 1960 $2,202.3 million. Request for 1961 is $1,021 million. Total $3,223.3

million.

Total cost of the *Titan* program is figured at about $5 billion.

Cost of 14 squadrons, including development costs, averages out at $335 million.

Not including development costs, the price of a *Titan* squadron ranges from $138 million to $166.5 million, depending on the configuration. However, individual cost of each *Titan* is put at $1.9 million. Cancellation of the *Titan* program would save about $2.5 billion, that is, the $5 billion estimated total costs, less $2.1 billion cost through 1960, less cancellation costs.

On Dec. 1, 1959, the *Titan* was upgraded for the last 8 squadrons to include storable potential, in-silo launch and uprating of the nose cone—at a cost of $400 million. The addition previously of the improved all-inertial guidance has cost $179 million.

MINUTEMAN

Cost of the first *Minuteman* installed in its inverted silo is estimated to be $2 billion. After the missile gets into production this cost is expected to drop to below $1 million.

Annual cost of maintenance is expected to be about $135,000 each.

Minuteman will have two configurations—one hard and dispersed and the other mobile on trains.

Build-up of the operational hard force will start in mid-1962. The mobile system is some months behind this.

Minuteman missile sites will be 5 miles apart with multiple control facilities.

In the mobile configuration each train will carry several missiles with at least one launch control center. According to testimony "the train will be mobile, moving from point to point, depending on the intelligence cycle or the identity of this location to be determined."

All inertial guidance tests have been carried out on the sled track at Holloman AFB.

First prototype rail car test will be made at Canaveral.

OTHER AF REQUESTS

Other Air Force missile procurement requests were: *Hound Dog,* $170.2 million; *Skybolt,* $10 million for operational support hardware; *Bomarc* $50 million (dropped from $421.5 million after appraisal of air-defense program); *Mace* ($91.6 million in Fiscal 1960), $12.8 million to "buy out" remaining leadtime items; *Quail,* $71.2 million; *Bullpup* $16.2 million (operational and training version); *Firebee,* $19.3 million; OQ-1D (Radioplane division drone), $2.6 million.

POLARIS

Polaris will be available for deployment in calendar 1960.

Tactical hardware has been installed in the first submarine.

The inertial guidance system and the fire control system have been successfully tested.

There are 9 *Polaris* submarines now under construction.

Missiles are being produced on a conforming schedule. Crews are in training to be ready for each new submarine. Tenders and operational support facilities are under concurrent construction.

The *Polaris* budget breaks down as follows (in thousands):

Shipbuilding/Conversion	$378,032
Aircraft/missile procurement	149,591
Other procurement	13,383
R&D, test and evaluation	373,609
Operation and maintenance	26,017
Total requested	$ 940,632

Another $11,580,000 for separate military construction would bring the total '61 *Polaris* program to $952,212,000.

Total cost of the *Polaris* submarine program—45 submarines through fiscal 1964—would be $9.9 billion.

The Air Force is still having manual troubles. The following conversation is recorded between Chairman Mahon and General Ritland:

Mr. Mahon: "I would like to know what we are paying in the Air Force for manuals for the missile program."

Gen. Ritland: "All of the missiles, the total?"

Mr. Mahon: "Yes. I have some information to the effect that it runs into many millions of dollars."

Gen. Ritland: "It is costly. However, the complexity of all missiles and all the ground support equipment requires manuals for training for operators and maintenance and repair."

Mr. Mahon: "This is a field which is quite expensive, but to spend $40 or $50 or $100 million on manuals would seem almost beyond comprehension. Do you know about this, General?"

Gen. Ritland: "Yes, Sir."

Mr. Mahon: "How Much?"

Gen. Ritland: "It runs in the order of $100 million."

PERSHING

The *Pershing,* two-stage, solid-propellant successor to the Army's ground-to-ground *Redstone* has cost about $280 million to date. The 1960 appropriation was $145.8 million including $132 million for R&D and $13 million for procurement. The 1961 request is for $158.8 million. Total program cost is estimated at $1.2 billion through fiscal 1965. The *Pershing* intended for Army field use would carry only an atomic warhead.

OTHER ARMY MISSILES

The Army has included $109.9 million in the '61 budget for *Nike-Hercules.* More than 400 will be used for training between now and 1964.

The *Hawk,* a ground-to-air defense missile against low-flying aircraft, is programed for $94.5 million.

Other Army requests: *Redeye* $11.4 million; *Honest John, Little John,* amounts unspecified; the French *SS10* and *SS11* antitank missiles, amounts unspecified; *Sergeant* $52.1 million; *LaCrosse,* unspecified, however, $167,336,765.04 has gone into the *LaCrosse* from inception of the program to 25 Feb. 1960.

NAVY MISSILE SHIPS & NUCLEAR POWERED SHIPS & SUBMARINES

The Navy has 70 guided missile ships authorized.

The Navy has 40 nuclear-powered ships presently authorized with budget request bringing the total to 46.

Ten have been completed, 26 are under construction, 4 are pending contract award and 6 are requested in the '61 budget.

Cost of newest nuclear subs is placed at $57.2 million. The size is 3,750-ton surface displacement or about 200 tons larger than the Nautilus, which cost $90 million.

The Navy budget also includes $4.9 million for an oceanography research ship—a floating laboratory.

It also includes $20.8 million for a deep diving experimental submarine to test hull structures, sonar equipment and weapon systems for combat subs of the future.

ASW

Navy will shortly award a hydrofoil ASW ship contract, first authorized in FY 1961. Specs call for a 115-ton, 110-foot craft with two types of sonar, one conventional and one with a variable depth feature. Initial hydrofoil craft lifetime is pegged at three years.

The service complains that reliability, particularly shelf life, of sonobuoys is too low. Therefore in FY 1961 some sonobuoy money will go into finding out why. Further, sonobuoy specs will be tightened up so that manufacturers will turn out a standard product. Not only performance specs but detailed specs as well will have to be met now. Navy believes that such techniques will go far to solving its reliability problems.

ASW commanders might get some help from two hardware pieces that the new budget will be buying. First is a device said to greatly increase the accuracy of sonor detection and localization at long ranges; second is a modification to existing sonars "that will increase detection ranges about 30%."

Lanphier Hits Hard at Defense Policy

Accuses President Eisenhower of leading 'incompetently to a point where we are in jeopardy of our national life.'

Numbers and mobility of ballistic missiles is our only hope of building an invulnerable deterrent against massive attack, according to Thomas G. Lanphier, Jr., outspoken critic of Administration defense policies.

And accelerated funding and manufacture are necessary if we are to build this deterrent in time to save the nation from disaster, he said in a speech to the National Press Club.

Lanphier pointed out that our entire operational ICBM force is now only one soft aiming point for the enemy. The *Atlas*, although testing out satisfactorily, is not currently planned in significant operational numbers and deployment for another two years. The *Titan* is proving itself a competent weapon, but its development is much farther behind schedule than is popularly supposed, according to the former Convair vice-president.

Continuing his attack on President Eisenhower's defense leadership, he denied any political aspirations. He stated in answer to a question that he believed Sen. Stuart Symington (D-Mo.) is the Presidential candidate most likely to lead the nation in a realistic and effective defense program. He also said that should Symington become President he would be happy to do anything Symington asked of him, but that he was not campaigning for him and was nobody's "advance man."

• **Three musts**—The free-swinging missile man—who quit his job at Convair in order to be free to speak his mind—feels that the U.S. needs three categories of weaponry to survive. These are an invulnerable deterrent against massive attack (all-out war), a limited war deterrent, and a home guard.

As for the first point, Lanphier contended that neither in numbers nor mobility are our present ballistic missiles equal to the job. Mobile ICBM's—such as *Polaris* and *Minuteman*—are highly desirable but will be limited in performance even when finally available and will remain limited so long as we continue to restrict ourselves from underground testing of nuclear warheads. He said that operational *Polaris* systems—complete with submarine, crew, missile, and assigned targets—are still more than two years away.

One of Lanphier's main contentions is that our leaders have been unrealistic in appraising the enemy's missile strength. His opinion is that the Russian ICBM lead "could well exceed the 150 missiles General Power has conservatively estimated as needed to wipe out the Strategic Air Command." He also stated that it's a "critically dangerous fallacy" to assume the Soviet's guidance efficiency inferior to ours.

• **Statement of charges**—Other Lanphier points in criticism of President Eisenhower "for letting the wrong element of the Government dominate the size and shape of our defense forces of tomorrow":

• Present IRBM warheads are too large. They must be made smaller to allow longer range and more effective payload.

• "Push-button war" is here today, and we must recognize the fact.

• World War III has already begun and we are losing it.

• Critics of defense policy are few—not because few feel we are in a dangerous position but because those qualified are in positions where they either cannot speak out or their criticisms would be discounted as coming from "munitions mongers" or partisan, self-serving politicians.

• "New" categories of weapons—unrecognized as such—include national political philosophy, education, economics, propaganda, and outer space. Communism excels in all these; our only hope is to excel in physical military weapons systems including conventional forces needed to deter limited aggression.

• We do not—and will not for several years—have an effective warning system against missile attack.

• We have no home guard or national program for fall-out shelters.

• Our intelligence, sketchy at best, is not affirmatively used by our defense planners.

• Qualitative development in defense is encumbered by peacetime regulations and restrictions, and is largely in the dark as to progress and problems encountered by the enemy and known to our intelligence.

• Our concentrated population, lack of fall-out shelters, and lack of missile attack warning make us more vulnerable in an exchange of nuclear weapons than the Russians.

• **What to do**—To remedy our dangerous situation, Lanphier advocated the following immediate actions:

• Put SAC on alert with a fourth of its bombers airborne and keep them airborne for at least the next three years.

• Add 100 *Atlas* and 20 *Titan* underground sites by mid-1963.

• Accelerate *Polaris* and *Minuteman* toward fully operational status by 1963-4.

• Resume underground nuclear testing.

• Accelerate missile-warning satellites *Midas* and *Samos*.

• Begin serious development of an ASW system.

• Prosecute a sensible anti-ICBM system—most likely from space.

• Fund a modern and sufficient airlift for the Army and Marines.

• Prosecute nuclear propulsion for space and aircraft.

• Cancel the *Bomarc* and *Nike-Zeus*.

• Cancel the nuclear aircraft carrier.

• Unify the services.

• Require Joint Chiefs of Staff to build defense budgets on a functional basis related to the threat.

• Unify the space effort.

• Keep Congress and the executive branch advised of the estimated threat.

• Inaugurate a civil defense home guard.

• Establish and maintain a government agency for long-term planning of arms control.

• Substitute "sacrifice and survival" for "peace and prosperity" as a national watchword.

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At speeds up to 24,000 RPM precision rotor bearings in inertial guidance and navigational systems are highly critical components. Early research and development in design and manufacturing at New Departure is solving the problem and thus winning vital roles for N.D. integral rotor bearings in missile projects. For example, "B" Series bearings with separable inner ring developed by N.D. are helping set performance records in such inertial guidance systems as the AChiever.

New Departure is also supplying high-precision rotor bearings for the inertial guidance system in Polaris. These bearings, through advanced manufacturing techniques, exacting inspections and controlled environmental tests, backed by 50 years of laboratory testing experience, give precision and uniformity far above the most precise industry standards. They promise new performance and *reliability* for the submarine-launched IRBM.

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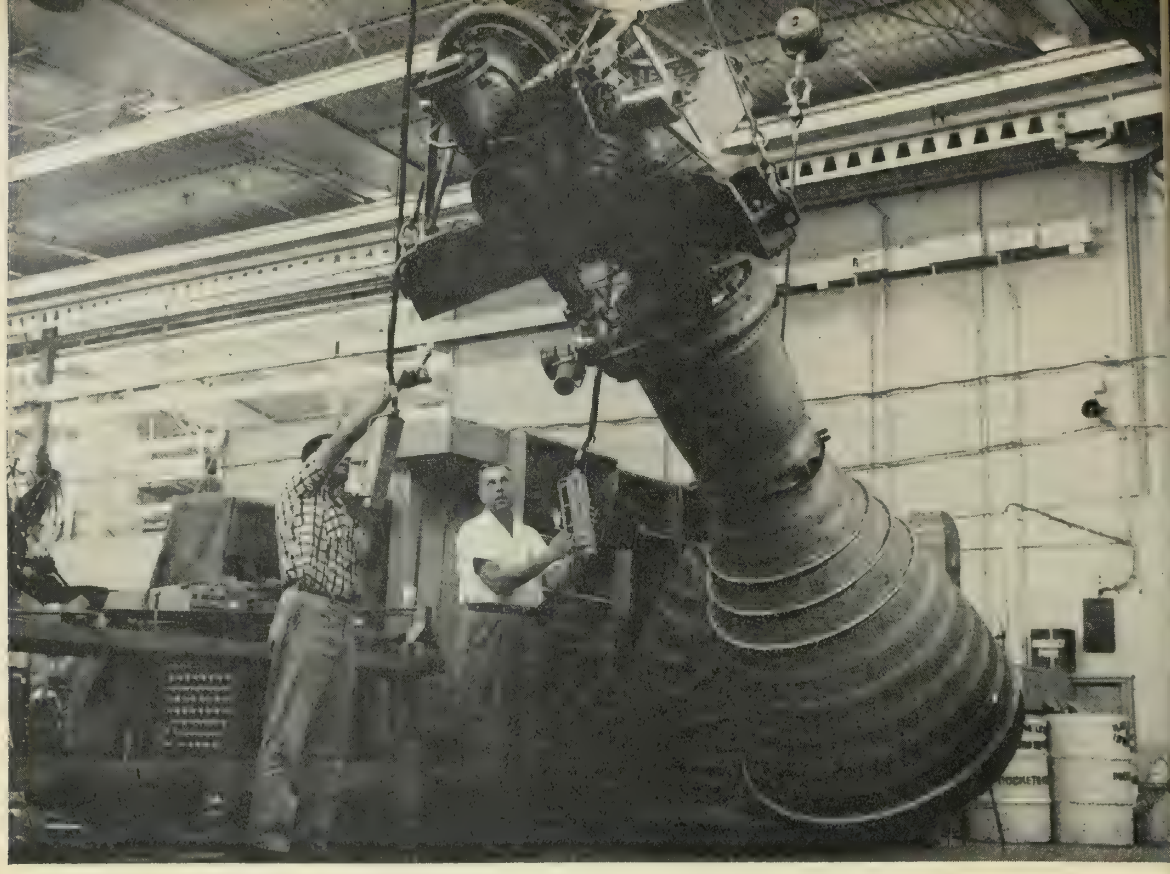


propulsion engineering

X–Series Leads to Simpler Engines

by Frank G. McGuire

CANOGA PARK, CALIF.—Development of a previously unannounced family of experimental rocket engines has been disclosed by Rocketdyne Division, North American Aviation.

The Air Force-funded program has contributed significantly to simplification of large liquid rocket engine designs, according to the company.

In the first of the series, dubbed X-1 by Rocketdyne, the engine was reduced to eight major components, in contrast with the 88 major components of the typical large liquid rocket engine.

The X-1 is a non-flying, test-bed engine. But innovations from the experimental powerplant have been incorporated in the H-1 *Saturn* engine, the MA-3 *Atlas* engine, the *Thor* engine, the 400,000-pound-thrust E-1 and million-pound-thrust F-1.

Development of the X-1 began in mid-1957, with a production-model *Thor* power plant as a start. Rocketdyne engineers began eliminating every system and component possible. Engine thrust was boosted by over 50%. Reliability was significantly increased.

• **Improvements**—The original *Thor* engine was simplified by:

• Eliminating the alternate complete-start system, with its tanks, pressurization and valving. A compact solid-propellant gas generator developed by Rocketdyne's McGregor, Tex., plant was substituted to start the main turbopumps spinning.

• Eliminating the pneumatic system for main fuel valve opening by a new system described only as "utilizing available energy sources."

• Eliminating the lubrication oil tank and its pressurization system. The engine now uses an additive-type, high-pressure lubricant fed into the fuel via a no-moving-parts blending mechanism. (The additive is a commercially available product being used for the first time in this application. Rocketdyne declines, however, to identify the additive or its chemical family.)

• Eliminating vernier engines for roll control by using turbopump exhaust gases to induce the required torque. The pump's exhaust gases are ducted to an appropriate point and deflected as directed by guidance requirements. The deflection mechanism has one moving part.

• Simplifying the propellant duct-

ing system from turbopump to combustion chamber by use of a lightweight, flexible connection designed by Rocketdyne. Brazed joints replace B-nuts wherever practical.

• Improving ignition methods.

The resulting X-1 experimental engine, first run in early 1958, also possesses a higher specific impulse than the original *Thor* engine. Total impulse remained about the same—being principally a function of tankage.

Still another simplification resulted from X-1 performance characteristics. Extremely rapid engine cutoff at a desired point eliminated the need for final velocity control by vernier engines. Engine cutoff impulse time has been reduced by 75% as compared to previous engines, thus bringing it within needed guidance tolerances without vernier correction.

The lack of complexity helps in one more critical operational aspect of large rocket engines—fewer components and systems mean simpler and less time-consuming checkout procedures.

• **Innovations**—The "final" X-1 configuration bears little resemblance to the original *Thor* engine which served as its springboard. Principal *Thor* features retained in the X-1 are the thrust chamber and regenerative cooling.

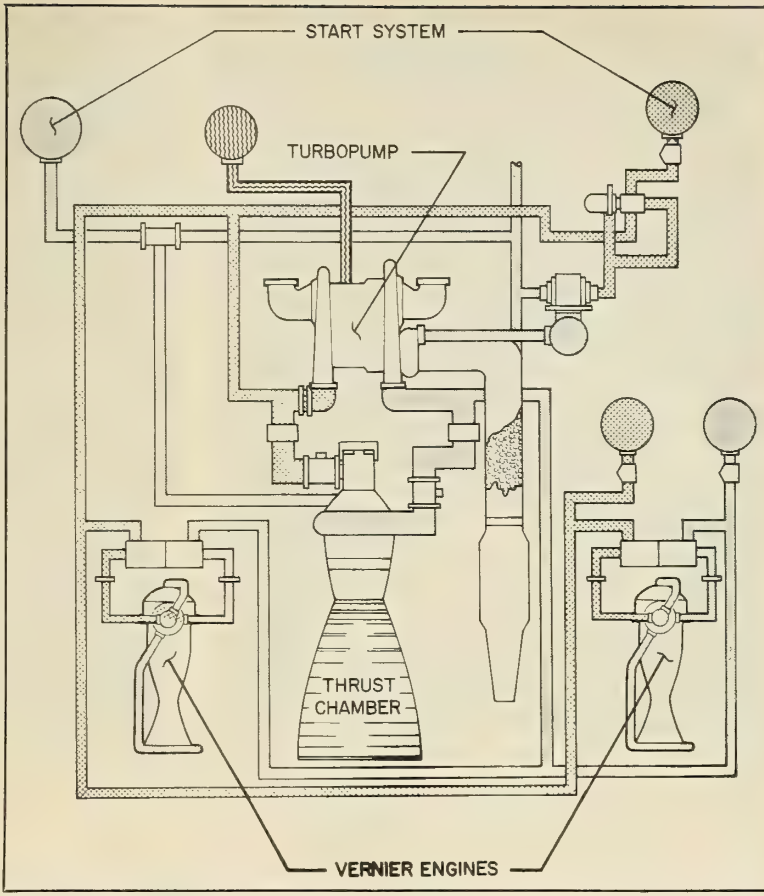
Thrust level of the experimental engine has been varied from 100,000 pounds to "well in excess of 200,000 pounds," the company says. Although not throttleable in present operation, the X-1 may be modified easily to include this capability.

The X-1 concept reverses near-traditional approaches to performance gains, Paul Castenholz, Rocketdyne's program manager for experimental engines, points out. In nearly all propulsion systems, from missiles to automobiles, performance-boosting designs are accompanied by increased complexity and/or increased size. This is not so with the X-1 despite its increased efficiency and use of advanced fuel combinations.

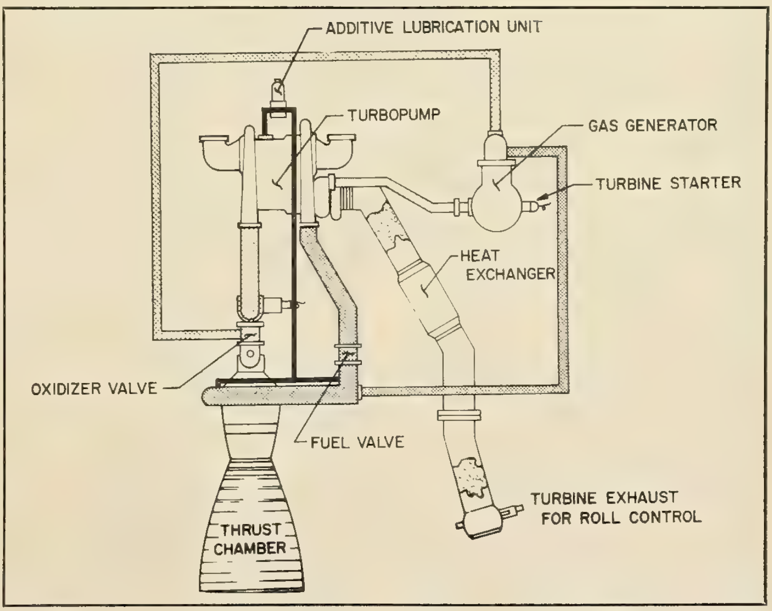
Elimination or simplification of the engine's systems brought greater freedom of tolerance for the remaining systems by reducing the number of critical features involved.

Developments made during the X-1 program have not created or compounded problems in other systems of a missile. Proving the feasibility of eliminating vernier engines for roll control poses no hurdle for guidance and control systems. A simple—almost elemental—circuitry modification would be the sole requirement to control the turbopump exhaust gas deflection system.

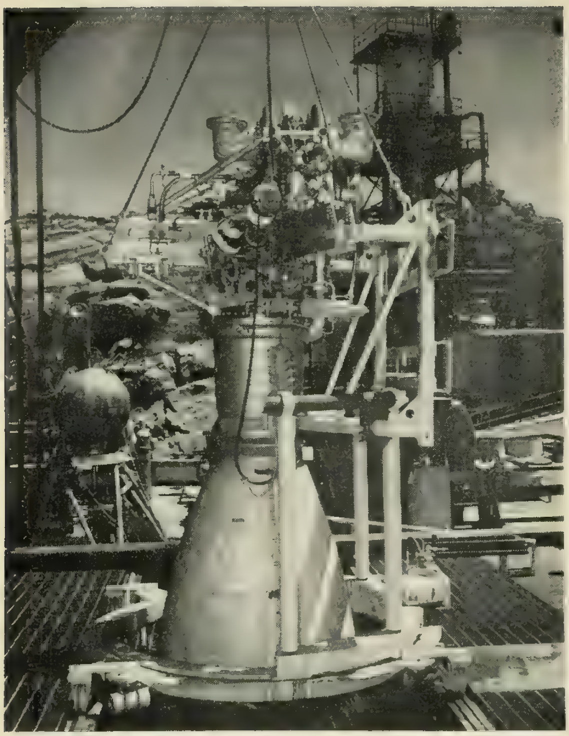
Concepts developed and proven in X-1 studies may be scaled up or down,



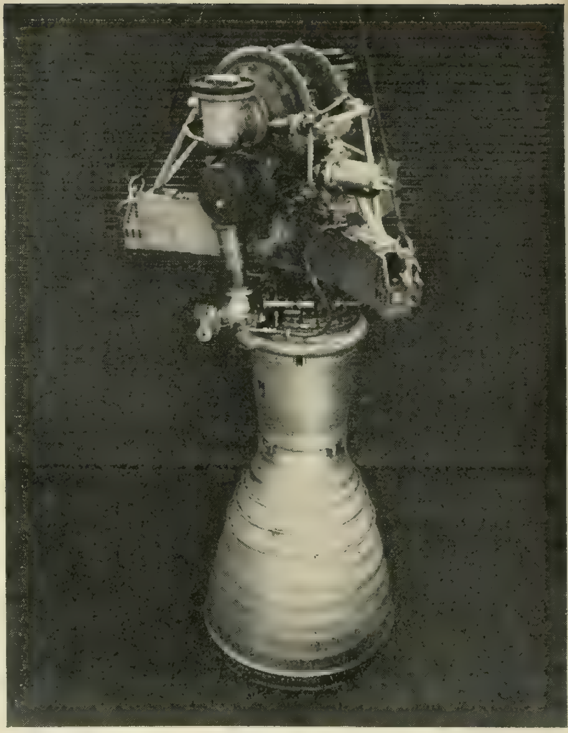
SCHEMATIC DRAWING of typical rocket engine system with tank start system, and vernier engines for roll control.



X-1 ENGINE, in similar drawing, shows innovations such as turbine spinner replacing tank start system, additive lubricant system and turbine exhaust for roll control.



ENGINE being installed in static test stand at Rocketdyne's field propulsion laboratory. New concepts were extensively tested over a period of two years.



X-1 ENGINE uses beam-type mount rather than usual tripod type to save weight, reduce fabrication time. Solid propellant turbine spinner is in dome at upper right.

Castenholz says, giving the project almost universal application to other engine design studies.

Such innovations as fiberglass-wrapped combustion chambers, brazed line connections, and other fabrication features have been proven on the X-1. As with any test-bed engine, the location and configuration of advanced hardware can be made with considerable freedom. Incorporating such developments into production "packages" is sometimes a problem. Adapting systems to fit a given space and weight requirements call for imagination.

• **Weight cut**—In the X-1 engine, weight was chopped by about 10% in comparison with comparable-thrust production engines. Minimum X-1 diameter requirements were governed by use of the existing *Thor* thrust chamber. But the engine is about two feet shorter than its predecessor.

The MA-3 engine now being used in *Atlas* is "pretty close" to the X-1 concept of simplified powerplants having greatly improved reliability, Rocketdyne says. The MA-3 uses separate turbopumps for each booster. This allows the turbopump assemblies to be jettisoned with the booster engines, rather than hauled aloft as dead weight.

The H-1 engine for the *Saturn* vehicle is "much closer" to the X-1 than the *Jupiter* IRBM engine generally thought to comprise *Saturn's* powerplant. Size and simplicity of the X-1 approach makes the clustering of such engines somewhat less complicated in terms of overall systems, controls and checkout.

The X-1 has been operated with standard cryogenic fuels as well as storable propellants. Company officials say fluorine and hydrogen could be used also.

Rocketdyne is continuing its X-series experimental engine program with even simpler versions of the X-1. Exactly how many developmental engines are involved has not been disclosed, but the company says it is "well into subsequent X-series numbers."

Part of the advanced design work now underway includes studies in radical thrust chamber design, including the plug nozzle concept.

Funding under a product improvement contract is through the USAF Ballistic Missile Office, Air Materiel Command.

Firing Record Broken

Two crews on Rocketdyne's horizontal test stand at Canoga Park, Calif., have completed a record series of 110 hot firings without a malfunction.

The firings took place between November, 1959 and January, 1960.

'Hottest' College Wind Tunnel Going at Stanford

Stanford University has disclosed the operation of a 12,000-mph wind tunnel, which it calls the "hottest" on any college campus. The hypersonic airstream can be heated to 14,000°F.

The tunnel was financed with a program sponsored by six companies: Convair Division of General Dynamics, Douglas Aircraft, Hughes Aircraft, Lockheed Aircraft, North American Aviation and Northrop. The research program is supported under contracts with the Air Force's Arnold Engineering Development Center at Tullahoma, Tenn.

The hypersonic airstream is designed to imitate conditions a space vehicle meets on re-entering the earth's atmosphere. It operates on the principle of arc discharge. A 200,000 watt-second spark sets off each shot, which lasts a 1/25,000 second. The discharge takes place in a chamber filled with high-pressure air. The hot arc causes pressure to rise to 20,000 psi, bursting a nylon diaphragm so that the air flows into the tunnel's vacuum chamber.

Models and materials are mounted at the mouth of the nozzle. The length of the wind tunnel is over 20 ft. The vacuum in the tank is reduced to one-millionth of an atmosphere.

Continuous Mix

Navy, Aerojet Develop System for *Polaris*

A continuous mixing process has been developed for manufacturing solid propellant for the *Polaris* fleet ballistic missile, the Navy and Aerojet-General Corp. announced last week.

Propellant mixed with the new process has been fired in more than 100 small-scale *Polaris* static-test motors, Rear Admiral William F. Raborn Jr. reported. Raborn, director of the Special Projects Office in the Bureau of Naval Weapons, added: "It gave the desired performance."

In the Aerojet process, only 20 or 25 pounds of the propellant are under preparation at any given moment. Under the process used for the first round of *Polaris* production, propellant is mixed in batches of about 2200 lbs.

Raborn credited Aerojet engineers under Dr. Karl Klager at the Solid Rocket Plant near Sacramento, Calif., for developing the new process in less than a year, ahead of schedule. Klager won the Navy's Distinguished Public Service Award in 1958 for his work in developing the polyurethane propellant used in *Polaris*.

• **Reciprocating Action**—The Navy gave few details about the nature of the process. However, it was learned that Aerojet makes use of a machine manufactured by Baker-Perkins Inc. of Saginaw, Mich.

The machine, which Baker-Perkins calls the Ko-Kneader, consists of a jacketed barrel containing a screw with a complex interrupted thread and a series of projections. The projections create a reciprocating action that achieves intensive mixing. The barrel is hinged longitudinally so that it can be opened for cleaning. The jacket can be used in cooling.

The propellant industry generally agrees that continuous processing reduces the hazards of production, cuts labor costs and improves quality control. Under the gross-mix process, quality tests were made on 10 lbs. of each 2200-lb. batch. With continuous processing, tests are made regularly on small amounts as the propellant passes through the mixer.

Continuous processing also assures more uniform performance. This factor is important for assuring accuracy in firing the weapon from a continually shifting underwater location.

Thiokol Chemical Corp. and Rocketdyne Division of North American Aviation also are developing continuous mix processes. The Navy said the Aerojet facility represents the first large-scale application of the continuous mixing process.

AEC, NASA Battle for *Rover* Control

Two Atomic Energy Committee witnesses back ground launch for first flight; new reactor tests planned

by Jay Holmes

A tug of war between top officials of the Atomic Energy Commission and the National Aeronautics and Space Administration is under way for control of the Project *Rover* nuclear rocket.

NASA Administrator T. Keith Glennan has suggested that *Rover* administration personnel be transferred from AEC headquarters in Germantown, Md., to NASA. AEC Chairman John A. McCone—following a suggestion by Sen. Clinton P. Anderson (D-N.M.), chairman of the Joint Congressional Atomic Energy Committee—proposes that the *Rover* staff at NASA move to the AEC.

Very few personnel would be involved in the transfer, whichever proposal were adopted, probably only three or four. There is no suggestion of moving people in the field, either at AEC or NASA installations. The issue at stake is merely control of the project. At present, it is divided between the two agencies.

In other developments concerning the nuclear rocket last week:

• Two witnesses before the Joint Atomic Energy Committee voiced support of a plan by the AEC's Col. Jack L. Armstrong for a direct ground launching as the first flight test of the *Rover* rocket, which probably will be in 1964 or 1965.

• The AEC announced plans for two tests this summer of *Kiwi* prototype rocket reactors, following upon the successful first test last summer.

The dispute over *Rover* control was touched off in February when Anderson raised public objection to a Budget Bureau cut in *Rover* funds that would have delayed the completion of ground testing from 1963 to 1964. The Budget Bureau later allowed the AEC to restore *Rover* funds by shifting from other AEC projects. However, Anderson proposed that the nuclear rocket would move faster if complete responsibility were given to the AEC through the ground tests. He said NASA was not as enthusiastic about nuclear rocketry as the AEC.

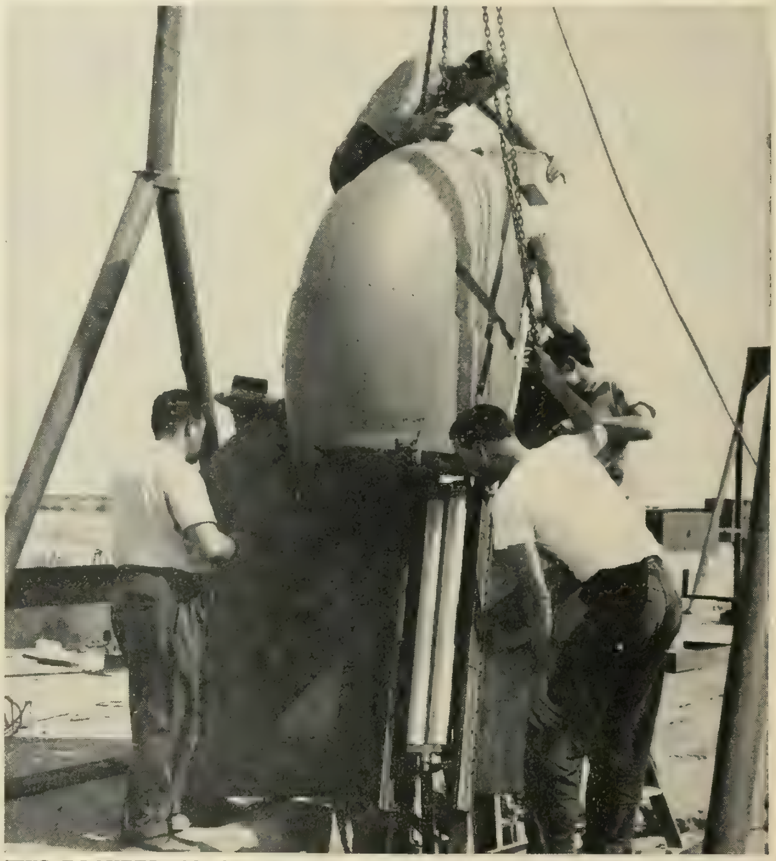
Anderson proposed that NASA and AEC representatives get together for discussions about control of the project. The Glennan and McCone suggestions were made at a meeting held at Anderson's suggestion. A further meeting was to take place last week.

• **Four uses**—At a hearing before the committee, Krafft A. Ehricke, director of the *Centaur* work at Convair Division of General Dynamics Corp., said there are four principal "domains" for a nuclear heat-exchange rocket such as *Rover*. He listed them as: earth-to-moon transport and lunar base maintenance, fast emergency rescue missions to the moon and the inner solar system, instrumented probes to the outer solar system and reconnaissance flights to Venus and Mars.

"I favor development of a demonstration system and flight test as soon as possible," Ehricke declared. He told MISSILE AND ROCKETS this would entail ground launching for the first test instead of orbital or upper-stage launching.

Dr. Raemer E. Schreiber, head of the scientific staff developing *Rover*, told the committee that since Anderson protested the slow pace "things have been occurring rather violently." He urged early flight testing. Asked by M/R whether he favored ground launch as opposed to launch from orbit or as upper stage, Schreiber re-

Ejector Rocket on B-52 Pilot Capsule



TWO ROCKETS with slow-burning propellant made by Thiokol Chemical Corp. are used in B52 ejection system to provide greater acceleration control.

plied, "Yes, emotionally I do."

Harold E. Finger, NASA chief of nuclear engines, is the chief proponent of orbital launching for the first test. Finger favors such a test because, he says, it will provide more useful data for engine development than a ground launching.

Partly, the argument revolves around the point that a ground launching apparently would accomplish nuclear flight somewhat earlier than an orbital or upper-stage launching.

"But the delay caused by orbital launching would not be a delay in the program," Finger told M/R last week. "It would only be a delay in the first flight. Even those who recommend ground launching agree that such a launching is only a preliminary to an orbital test."

"The real point," Finger continued, "is which kind of first test will do more for the overall flight test program."

The NASA official said an upper stage nuclear rocket is a third possibility for the first flight test of the *Rover* rocket.

Finger said there are several possibilities for the first actual *Rover* mission. He said he believes it will be an upper stage of the chemical booster that follows after *Saturn*. This might be a cluster of four to six F-1 engines with 1½ million lbs. thrust apiece. Or it might be a combination of a single F-1 with several smaller engines such as the H-1, eight of which are being clustered into the *Saturn* booster.

• **Summer tests**—The AEC plans for two reactor tests this summer will be designated the *Kiwi-A Prime* series. Like *Kiwi-A*, they will be held at the Jackass Flats area of the Nevada Test Site.

Both tests will use the same test cell and other facilities. The original *Kiwi-A* has been reassembled and connected to the test cell without nuclear components. It will be used as a mock-up for non-nuclear cold-flow experiments prior to the tests of the new reactors.

The first of the two reactors to be tested is designated *Kiwi-A Prime*. It is now being assembled at Los Alamos. After cold critical tests there, it will be moved to Nevada, where tests are expected to begin by midsummer.

The second reactor, designated *Kiwi-A3*, will be tested shortly after completion of the tests on *Kiwi-A Prime*. The AEC said two reactors will be used to perform a wide variety of tests and to obtain more data that would be possible with a single reactor.

The *Kiwi-A3* reactor will undergo endurance testing to determine safety margins and limits of performance. Tests will continue until there is positive evidence of damage to the reactor, the AEC said.

Schreiber told the committee that work is also under way on a new generation of *Kiwi* reactors in which a beginning will be made on marrying the reactor to the liquid hydrogen supply system, the liquid hydrogen pump, the regeneratively cooled nozzle and simplified control system.

A logical extension of the *Rover* program, Schreiber said, will be the investigation of problems related to very high power levels. Detailed studies will be necessary to learn the effects of drastic changes in reactor size or power. New facilities and a general expansion of the *Rover* program will be necessary for actual testing of large engines, he added.

Aerojet to Build SNAP-8 Converter

30KW device to cost $8 million; flight due in 5 years; system designed to operate in space more than a year

The National Aeronautics and Space Administration has selected Aerojet-General Corp. to build the electrical conversion equipment for SNAP-8, a nuclear power system capable of generating up to 60 kilowatts in a space vehicle. This is enough power to operate a small electrical propulsion system.

Atomics International Division of North American Aviation is developing the reactor under an Atomic Energy Commission Contract. The conversion equipment to be developed by Aerojet will generate 30 kilowatts. However, the reactor will generate enough nuclear energy to power two conversion systems in a single vehicle.

NASA and Aerojet reached a preliminary agreement March 24. Aerojet was chosen from eight competing contractors. Formal negotiations on the contract are now in progress. NASA said Aerojet estimated that the contract would cost $8 million.

Robert E. English of NASA's Lewis Research Center told the Joint Congressional Committee on Atomic Energy March 24 that the 30-kilowatt version would be suitable for use with *Atlas-Agena* space vehicles while the 60-kilowatt model will be used with *Atlas-Centaur* vehicles. He said the 60-kilowatt system, including reactor and shielding, would weigh about 3000 lbs.

English said the 60-kilowatt SNAP-8 could be used to power an electric rocket in a 9000-lb. satellite lifted into a low 300-mile orbit by the *Atlas-Centaur*. The electric rocket then would lift the satellite into a 24-hour, 22,000-mile orbit. After the satellite has reached its destination, the power supply then would be available for operating the communications equipment. J. R. Wetch of Atomics International told the committee it would be sufficient for continuous worldwide broadcasts of television signals that could be received by conventional home sets.

NASA said the system will be designed to operate in space for at least a year. The entire system is to be ready for flight in about five years.

SNAP stands for Systems for Nuclear Auxiliary Power. Those with odd numbers are low-output devices that make use of radioisotopes. Even-numbered systems are based on nuclear reactors.

• **Mercury heat transfer**—The conversion system to be developed by Aerojet will use mercury as a heat-transfer agent. A closed loop will carry mercury through the reactor, where it will be heated. This loop will pass through a boiler. A second loop will carry the mercury into the boiler, where it will be vaporized. The gaseous mercury will drive a turbine powering a generator, which will produce electrical power.

The gas then will be routed through

a series of tubes that will form a radiator several hundred square feet in area. On cooling, the mercury will condense into liquid and be pumped through the closed loop to repeat the cycle.

English told the committee an electric propulsion system used with SNAP 8 could raise a payload of 3000 lbs. to a 24-hour orbit if 40 days are allowed for the trip. If the time must be shortened, the payload is reduced as well.

Another application, he continued, is propelling an instrumented probe to Mars. Payload varies with intended trip time in the same way. Both a high-performance chemical rocket and a SNAP 8 electric rocket would deliver 500 lbs. to orbit about Mars in 250 days. But if the time is increased to 350 days, the payload with an electric rocket could be 3000 lbs., with 60 kilowatts available for use by the payload after it arrives.

• **Spectacular performance**—Wetch of Atomics International told the committee that a smaller nuclear power reactor, designated SNAP II, has been performing at design conditions since it was announced last November. The reactor, which weighs 220 lbs. without shielding, generates three electrical kilowatts.

"To date," Wetch said, "it has produced the energy required to replace nearly 100,000 lbs. of batteries at a continuous rate that would require about 1000 sq. ft. of solar cells, which would cost about $3 million. This is 10 times the projected cost of the nuclear power unit."

Wetch said small mercury vapor turbine-generator devices in the SNAP program have been operated for more than 1000 hours. Thompson Ramo Wooldridge Inc. is developing the conversion equipment for SNAP II.

The SNAP-2 reactor uses a homogeneous mixture of enriched uranium fuel and moderating material. The coolant is liquid-sodium.

• **Moon/Mars bases**—At another committee session, devoted to advanced reactor concepts, Dr. B. I. Spinrad of the Atomic Energy Commission's Argonne National Laboratory urged the development of large reactors suitable for providing power to set up permanent bases on the moon and Mars.

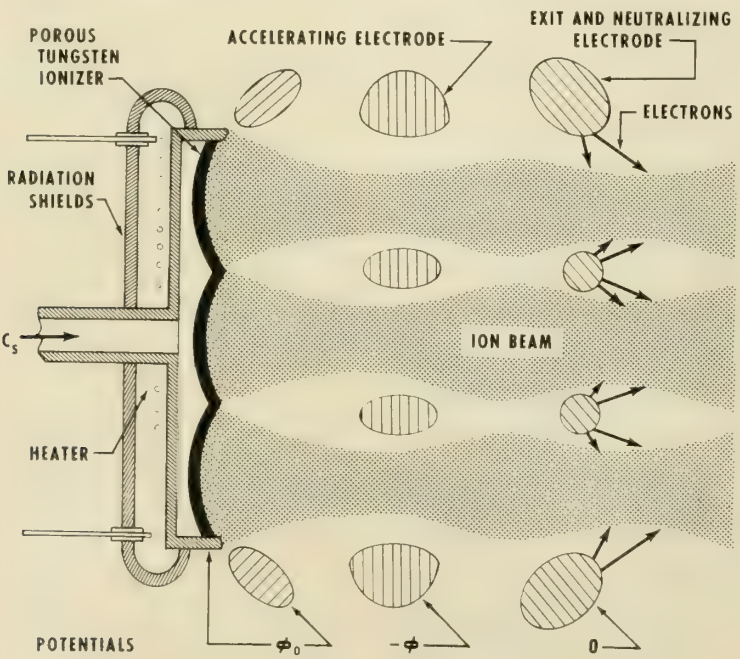
"With enough energy," he declared, "one needs to transport only shop and laboratory equipment to such locations. Ceramics and metals can be manufactured from local rock and converted into the materials for construction of living quarters, complex machines and, in fact, just about everything but biological necessities and (perhaps) the fuel itself.

He said it seems logical to spend from 10% to 20% of the overall cost of putting man on the moon for a power source.

Ion Rocket Efficient Above 1 KV

A cesium ion motor will be efficient only above a potential of one kilovolt, which corresponds to a specific impulse of 4000 sec., Dr. A. T. Forrester of Electro-Optical Systems Inc., Los Angeles, has told a scientific group.

Forrester is head of the Ion Propulsion Laboratory at Electro-Optical, which recently won an Air Force contract for "quick and dirty" construction of an ion propulsion unit. He spoke before a Philadelphia meeting of the American Institute of Electrical Engineers last month.



BUSINESS END OF Electro-Optical Systems' ion rocket is shown.

The optimum exhaust velocity—determined by a compromise between propellant demands and power demands of the motor—is in the range between 10^6 and 2×10^7 cm/sec., he said. This provides for accelerations of about 10^{-4} g—about 0.1 cm/sec^2.

Although this acceleration is very small, he pointed out, very sizeable velocity increases are possible when the acceleration is continued over a long time. For instance, an acceleration of 0.1 cm/sec^2 continued for six months would provide a velocity increment of 16 km/sec. Thus, accelerating for six months and decelerating for six months, it would be possible to travel about 100 million miles—far more than the distance to Mars or Venus—in a year.

Forrester said a cesium ion can be given a velocity of 10^6 cm/sec by an acceleration through 70 volts. A velocity of 2×10^7 cm/sec requires a 27-kilovolt potential difference. He concluded that this covers a fairly convenient range of voltages to handle.

• **Multi-aperture geometry**—Because of space charge limitations, Forrester continued, the cesium ion current from a single aperture cannot be greater than 3 milliamps at 5000 volts. Since the smallest operational ion motors will require about one ampere current, a multi-aperture geometry is necessary.

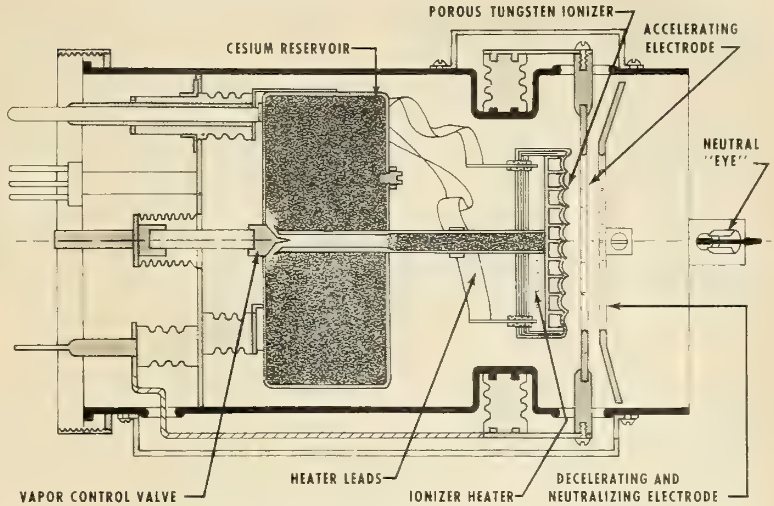
The tungsten ionizer must be in

particles of about one micron in diameter, Forrester declared. This is to provide for surface diffusion to avoid the buildup of cesium on the tungsten particles. He said that available sintered tungsten approaches the required grain size.

To make the exhaust neutral, in terms of both time and space, an electrode arrangement is necessary, so that the right amount of electrons will be mixed with the ion stream. This is accomplished by placing a second electrode downstream from the accelerating electrode. The second electrode is at ground potential, the potential of the hull of the space vehicle. The ion source is at a positive potential corresponding to the desired exhaust velocity. The intermediate, accelerating electrode is maintained at a negative potential. It provides an effective barrier to electrons that might otherwise be inclined to proceed upstream.

Forrester provided the two accompanying diagrams. Fig. 1 shows the business portion of an ion motor—presumably the design of the device his company is building for the Air Force. Fig. 2 is the overall design of an ion motor, including cesium source and body construction.

Since cesium melts at 83°F, it will flow easily into the feed tube. Very little heat is required to keep it in the liquid state.



OVERALL DESIGN of ion engine as seen by Dr. Forrester.

Air Force Gets Rugged Liquid Hydrogen Trailers

Four new 7000-gallon liquid hydrogen trailers were put into service by the U.S. Air Force last week.

The trailers, capable of hauling the supercold (—423°F) liquid from coast to coast, were designed and built by Air Products Inc. of Allentown, Pa.

The bulk of the U.S. supply of liquid hydrogen is produced for the Air Force at a plant operated by Air Products at West Palm Beach, Fla. With the new trailers, the Air Force will be able to ship tonnage amounts of the liquid cross-country to any point where it is needed for testing of nuclear or high-energy chemical rockets.

The Air Products plant is next to a Pratt & Whitney installation where a liquid hydrogen-liquid oxygen rocket is being developed for use in the *Centaur* vehicle. The engine will generate 15,000 to 20,000 lbs. thrust. Two such engines will be used in the *Centaur*, which will be used as an upper stage atop *Atlas* and as a final stage in the *Saturn* vehicle.

The National Aeronautics and Space Administration is receiving bids on a liquid hydrogen-LOX engine with 200,000 lbs. thrust to be used in the second stage of *Saturn*. Companies on the West Coast are among the bidders.

The trailers, built to military specifications, were designed for duty under battle conditions. They are capable of operating over boulder-strewn fields, on desert sands and in subtropical and salt-sea atmospheres. They also can be shipped in transport planes.

Each trailer consists of two chambers, with the space between the chamber walls evacuated to maintain insulation. The light weight of liquid hydrogen lessens the design problem of support for the inner chamber. The 7000 gallons of capacity weigh about two tons. The weight of an equivalent volume of water would be 30 tons.

Air Products will begin commercial production of liquid helium and liquid hydrogen this month at a new plant in Iselin, N.J. The liquid will be delivered by truck throughout an area of 600-mile radius. Shipments are planned by air freight over a much larger area.

Integrated design and construction allow increased production of one liquid when no production of the other is required.


TWO HYDROGEN TRAILERS built by Air Products await delivery to Air Force.

High Speed Underwater Nuclear Jet Invented

A nuclear jet engine that may propel both undersea and surface craft at speeds of more than 100 mph has been invented by a Boeing Airplane Co. engineer.

The inventor, L. J. McMurtrey—Navy systems manager in Boeing's advanced design section—said that operation of the underwater nuclear jet engine would be somewhat similar to propulsion through air except that water would replace air and that no fuel would be used.

In the new engine, water would be passed under ram pressure through a nuclear heat exchanger, then through a turbine and out the nozzle. Either a turbojet or ramjet type of engine could be used.

Materials Gaps Menace U.S. Security

Special committee finds lagging research effort is major factor, recommends a higher national priority

by John F. Judge

A materials barrier is effectively holding up the entire U.S. space effort and seriously endangering the national security.

This is the conclusion reached by the special Committee on the Scope and Conduct of Materials Research organized by the National Academy of Sciences. Its report was released last week.

The Committee, under Dr. Clyde Williams, president of Clyde Williams and Co., surveyed the total materials research and development activities of the nation to identify any critical gaps —and found it riddled with them.

A definite sense of urgency underlined the committee's general recommendation—a higher national priority for the materials research effort.

"If we were alone in the world we could take our time in working out solutions to these problems. But we are not alone. Instead, we are now aggressively challenged by a totalitarian system that is seeking to wrest leadership from us through more effective utilization of scientific progress," the committee report states.

Lack of sufficient basic scientific knowledge was cited by the group as one of the main reasons for the materials gap. Accelerated efforts in chemistry, physics, and mathematics, supplemented by cross-fertilization of scientific and engineering areas, are required. Unexpected potentials will result from such basic studies as investigation of molecular and atomic binding forces. This can only be accomplished through research.

• **Economic benefits**—The national economy can be expected to benefit from developments originally undertaken to meet national security needs. For example, the committee points to the improvements in electrical power generation, and chemical and metallurgical processing that will result from materials with higher operating temperatures and enhanced corrosion resistance.

Many complicating factors are anticipated. High melting materials will require radical changes in the processing and forming equipment currently in use. Most new materials will be of high purity and designed to operate in strange environments.

In addition to these, the necessity to make haste will further increase the cost problem. The demands of the space effort are such that developments that rolled along for years now must be rushed through in months.

The committee emphasized that crash programs, so often the solution in the past, are of decreasing effectiveness. Large research programs, initiated well in advance of actual needs, will reduce the frequency of crash programs and bring an overall savings of money and effort.

In this vein, the committee acknowledged that the pressing needs of national security do not often provide for large enough production runs of standard items to allow for cost recovery. It is obvious that industry cannot be expected to invest its own money and time in major materials efforts without proper arrangements to cover the costs involved.

The committee concluded this aspect by calling for higher national priority in the science of materials and in training of brain power. It said that materials development projects should be given more recognition as end-object programs in their own right.

• **Administrative needs**—Several improvements in administration of security-related materials R&D programs were suggested by the committee. The agencies mainly responsible for this area usually are the Armed Services, the Atomic Energy Commission and the National Aeronautics and Space Administration.

Although many commendable Government in-house, industrial and university laboratories are directly supported in these programs, it is clear that the demand for new materials is increasing much more rapidly than these facilities. End-item contractors have been forced to support research projects directed toward specific production and development problems and much of this work has not been part of any organized national program on materials development. This is simply because these programs of end-item contractors have not been identified as being concerned with materials.

The committee urges greater centralization of responsibility within each department and agency for materials R&D to alleviate this condition.

The Special Committee on Scope and Conduct of Materials Research

Dr. Clyde Williams, Chairman
President, Clyde Williams and Co.

Dr. Allen V. Astin
Director, National Bureau of Standards

Dr. Harvey Brooks
Dean of Engineering and Applied Physics, Harvard University

Alvin J. Herzig
President, Climax Molybdenum Co.

Dr. A. B. Kinzel
Vice President, Research, Union Carbide Corp.

Thomas H. Miller
Deputy Director, Bureau of Mines

Dr. John D. Morgan
Industrial Consultant

Dr. Thomas B. Nolan
Director, U.S. Geological Survey

Dr. Albert J. Phillips
Vice President, American Smelting and Refining Co.

Dr. C. F. Rassweiler
Vice President, Research and Development, Johns-Manville Corp.

E. Duer Reeves
Executive Vice President, Esso Standard Oil Co.

Professor Frederick Seitz
Head, Dept of Physics, University of Illinois

Professor Cyril Stanley Smith
Institute for the Study of Metals

David Swan
Manager-Planning, Union Carbide Corp.

Some of the more specific recommendations in this respect include:

• Within each military service there should be greater support for materials R&D as end-object programs in their own right. Full use should be made of all professionally qualified people, including those in uniform.

• The AEC should closely coordinate nuclear materials programs for military applications of atomic energy with other national security materials efforts.

• NASA should have a central materials staff.

• An agency in the Executive Office of the President of the U.S. should be responsible for assuring that the above steps are taken.

• **Priming industry**—The committee considered the question of providing incentives to stimulate the needed research. Here the specific recommendations include:

• Broadly defined objectives should be written into contracts while detailed reporting and accounting procedures are minimized. Contracts should permit purchase of necessary equipment and facilities construction including pilot plants. Adequate funding should be made available for two- to five-year research programs in the contracts.

• A patent policy based on the current one used by the Department of Defense, allowing the contractor to retain commercial rights to any invention.

• Provisions should be made to limit the extent to which "know-how" acquired over a long period of time with private funds has to be released under a Government contract.

• Existing knowledge should be much more effectively utilized in the solution of pressing national security materials problems.

• **Stockpiling**—In the matter of strategic materials, the committee suggested that the Office of Civil and Defense Mobilization should annually attempt to assess the supply-demand situation that is likely to exist five to ten or more years in the future for each potentially needed element and material.

As specific examples the committee mentioned the elements tellurium and rhenium as being potentially important but not on any present stockpile list. Tantalum, although already on the lists, has such future potential in high-temperature applications and electronics that greater supplies may well be required.

• **Information exchange**—The dissemination of technical information was divided by the committee into two distinct categories: the permanent technical information contained in printed journals, etc., and the information generated currently—either unpublished or not yet within the permanent body of technical literature.

The problem in storage and retrieval of published permanent literature is being effectively attacked by information systems such as the project currently under way at Western Reserve University with the cooperation of the American Society for Metals. There is need for more such projects.

It is in the area of currently generated information that the committee finds room for substantial improvement. It recommended a far greater effort to speed the process of dissemination.

In particular, it should be incumbent upon each agency to establish central organizations for collecting and disseminating information.

Further, management should encourage thorough information searches as prerequisites to any research and development proposals and programs.

Maximum support of technical societies by industry, financially and otherwise, is imperative—and the societies themselves should take on additional screening functions for reports in their particular areas.

The Government should step up its efforts to prompt declassification of all or part of reports as soon as the need for such classification has passed.

There should be greater support of research designed to lead to the swift exchange of information. Current lines, such as the Defense Metals Information Center at Battelle Memorial Institute, should be considerably broadened.

• **Basic research**—The last point of the survey touched on the role of the nation's universities in materials research. The committee makes it plain that the capabilities of universities in this field should not be misused in the solution of short-term pressing problems. Such institutions should be exclusively concerned with the double-barrelled task of increasing the national reservoir of basic scientific knowledge and training increased numbers of scientists.

Considerably more must be done in interdisciplinary materials research at universities supported by the agencies having the authority and funds. The only limitation suggested by the committee is that imposed by the ability of the universities to obtain and retain highly competent personnel and by their own desire to maintain balance within their individual structures.

Threaded through all of the recommendations made by the Academy's committee is a plea for more contact between government and industry—more communication on their basic materials problems.

Although the members of the committee recognize that some efforts have been made along several of the approaches recommended, they said that much more must be done if this country is to maintain and strengthen its position as the leader of the free world.

Metals Behavior

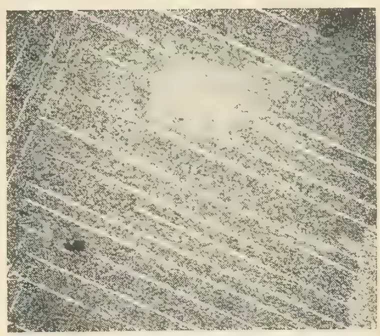
NBS Pushes Studies of Their Basic Properties

Increasing demands of missile manufacturers on common structural metals has revealed an almost complete lack of understanding of these metals' basic properties.

The National Bureau of Standards, in an effort to keep up with the current pace is engaged in studies to provide more information on the nature of the relation of metallurgical structure to the behavior of metals and the effects of heat treatment and temperature extremes on this relationship.

These mechanical studies are closely coordinated with bureau programs in metal physics, chemical metallurgy, and corrosion.

• **Metallurgical structure**—Metal fatigue is the most common cause of in-service components or machine parts failure. The prediction of this phenomena is critical to optimum design and the missile engineer must be able to do so with a high degree of accuracy.



REVERSED torsional loads produced these slip bands (white lines) on the surface of an aluminum specimen. Note that the direction of the bands differ from grain to grain.

In this area the bureau is doing much to foster the understanding of the relation between the structure of metals and the fatigue process.

Studies have shown that individual metal grains act independently of their neighbors and no evidence was found that grain boundaries or interaction with neighboring grains promote cracking.

Results of another study showed

GAS bubbles, resulting from repeated stressing on the surface of an aluminum specimen, appear under a strip of transparent tape. The horizontal line is powdered material extruded from the fatigue crack.

that the preponderance of fatigue cracks starting at the edges of a metal specimen is caused by the stress pattern, rather than by lower fatigue strength at the edges.

It has been long recognized that chemical reactions at the metal surface have an important influence on fatigue behaviour. The bureau observed that if a strip of transparent tape is applied to the surface of a fatigue specimen, bubbles form under the tape at about the same time that fatigue cracks are initiated. Since the bubbles are caused by gas liberated as a result of surface reactions, bureau scientists expect this to provide a useful means of studying such phenomena.

• **Temperature extremes**—With the possible exception of money, temperatures, high and low, are the biggest problem in rocketry today—and will remain so for a long time to come. The bureau has been involved in a long range study in this area.

The notion that the rate determining factor during creep of metals is the motion of defects through the crystal lattice by thermal activation under applied stress is an old one. But the many equations proposed to describe this have not been completely satisfactory. Tests conducted on high purity copper, nickel and their alloys have closely conformed to the concept of generation and exhaustion of lattice defects during the first stage of creep as well as to the parabolic strain-time law over limited ranges of stress and strain during the second stage.

• **High-strength steels**—Ordinarily, the fatigue strength of most ferrous metals is roughly proportional to the tensile strength. But when steels are heat treated to high hardness, this proportionality totally disappears, much to the chagrin of missile fabricators. While the tensile strengths soar to 200,000 psi and beyond, there is little or no improvement in the fatigue strength levels. The bureau's scientists attacked this problem in recent studies of high strength steels.

The studies indicated that retained austenite lowers fatigue strength. Under stress, retained austenite is transformed to untempered martensite, probably accounting for the deleterious effect. Most of this austenite can be eliminated in carbon and low alloy steels by suitable heat treatment.

The bureau's thermal metallurgical laboratory has been developing an ultra high-strength steel for the Navy's Bureau of Weapons. A modification of type 4340 steel attained high hardenability, sufficient ductility for use in the structural members of aircraft and tensile strengths up to 300,000 psi.

As for the future, the bureau expects to place increasing emphasis on the study of all aspects of atomic structure that influence the behaviour of metals in service. Techniques are being developed to obtain basic data that may provide new uses for metals. Ultimately this work may lead to new alloys that will withstand the most rigorous environmental and physical conditions generated by the space marathon.

Two Firms Propose R&D Program for Plastic Rocket

Another flurry of interest in plastic rockets has resulted from a request by the Army's Ordnance Materials Research Office, Watertown Arsenal, N.Y., for proposals involving investigation and development of plastic materials for solid-propellant motors and missiles.

The CTL Division of Studebaker-Packard Corp. and Amcel Propulsion, Inc., a subsidiary of Celanese Corp., joined in a proposal to OMRO which both firms feel could lead to the development of an all-plastic multi-stage missile.

The particular OMRO request concerned the basic task of concretely establishing and defining the criteria for plastic materials in solid rocket motors and missiles.

However, the companies jointly offered to begin immediately on a research and development program—aimed ultimately at the production of the plastic rocket.

The entire long-range program is divided into five phases, including, in addition to the initial research and development effort:

• Plastic rocket motor development—elimination of multiple construction motors.

• Plastic missile body development—include shrouds, nose cones flight cases and other containers.

• Integration of components—evaluation of resins including phenolics, epoxies, silicones and polyesters. Reinforcement materials include glass, Refrasil, quartz, nylon, Fiberfax, graphite and asbestos.

• **Static tests**—including simulated velocities up to Mach 2.5 at 4000°F, and rocket blasts up to 5000°F.

The basic propellant involved would be of the double-based plastisol types.

The concept of an all-plastic rocket was recently advanced by the Norair Division of Northrop Corp. (M/R Feb. 8, 1960, p. 25). At the time the idea was not in the form of a solid proposal, but materials research has indicated the concept's feasibility.

North American to Build Heat-Sound Effect Labs

Heat and sound effect laboratories will be constructed at the Columbus Division of North American Aviation, Inc. to determine what must be built into future missiles and aircraft in order to minimize damage from these two forces.

The heat effect laboratory will be equipped to blast air at more than 1000°F at metals and other materials to test friction resistance. A vacuum chamber will be included to simulate the reduced pressures of the upper atmosphere.

One cell in the sound effect laboratory will encourage the bouncing of noise and another will reduce this effect. A connecting passageway between the two cells will provide the testing area for instruments and materials.

Big Fused Silica Mirror Made for Balloon Flight

The largest fused silica mirror in existence has been fabricated by the Corning Glass Works for Project Stratoscope II.

The blank, currently being ground and finished by Perkin-Elmer, Norwalk, Conn., is 37 in. across, 5.5 in. thick and weighs 450 lbs.

When installed in the unmanned balloon, the mirror will be able to endure sudden temperature changes with-

out distorting the images because of the near-zero thermal coefficient of expansion of fused silica.

Project Stratoscope II will photograph solar and celestial bodies above the turbulence of the earth's atmosphere through a 36-in. telescope.

Information on the atmosphere of Jupiter and Venus, analysis of the division of Saturn's rings, measurement of Pluto's diameter and more insight into the Great Nebula in Orion are some of the results expected from the photographs.

Conducted by Princeton University with funds from the National Science Foundation, Office of Naval Research and the National Aeronautics and Space Administration, the balloon flight is scheduled for 1961.

Plastic Packaging Gives British Corrosion Troubles

LONDON—Plastic packaging incorporating acetic acid to limit chain lengths has caused some corrosion problems in stored munitions at the British Government's Armament Research and Development Establishment, Fort Halstead, Kent.

Trouble sources include materials using hair bonded with polyvinyl acetate, and parts encapsulated in polyester resins.

NRC Sets Up Space Vacuum Materials Lab

A Space Vacuum Laboratory has been established at National Research Corp., Cambridge, Mass., to evaluate materials, components and devices intended for use in space.

Test chambers at the new facility range in size from a 14-in.-diameter by 36-in.-high bell jar type system reaching pressures as low as 2×10^{-10} mm Hg, to a 3.5-ft.-diameter steel tank capable of pressures down to 4×10^{-10} mm Hg.

The equipment can be adapted to permit dynamic testing involving creep-rupture, rotary and linear motion, emissivity, thermal and electro-magnetic radiations and undamped vibrations.

Tests of up to a year's duration on certain electronic components are now being planned for one customer, according to Robert A. Stauffer, vice president and director of research.

Cost of advance tests of equipment to be sent on long missions run less than $200 per day of equivalent flight time.

The new laboratory will be under the direction of Dr. John C. Simons, chief of the firm's applied physics department.

How We Have Progressed in Nose Cones

A report on the work accomplished under Air Force contract by General Electric and Avco resulting in successful noses for both ICBM's and IRBM's; an examination of some of the special problems

Seventy tests of Air Force ballistic missile re-entry vehicles have been performed as of February 3, 1960. These tests—part of the AF IRBM and ICBM research and development program—have led to design of nose cones capable of bringing a warhead through the thermal thicket of the earth's atmosphere.

Both heat-sink and ablation type vehicles have gone through this extensive test phase. The work was performed under a Ballistic Missile Division contract: General Electric (Missile and Space Vehicle Department) and Avco (Research and Advanced Development Division) are prime contractors. Basic experimental work on the re-entry problem was done at Avco's Everett Laboratory and the resulting data furnished to both GE and Avco.

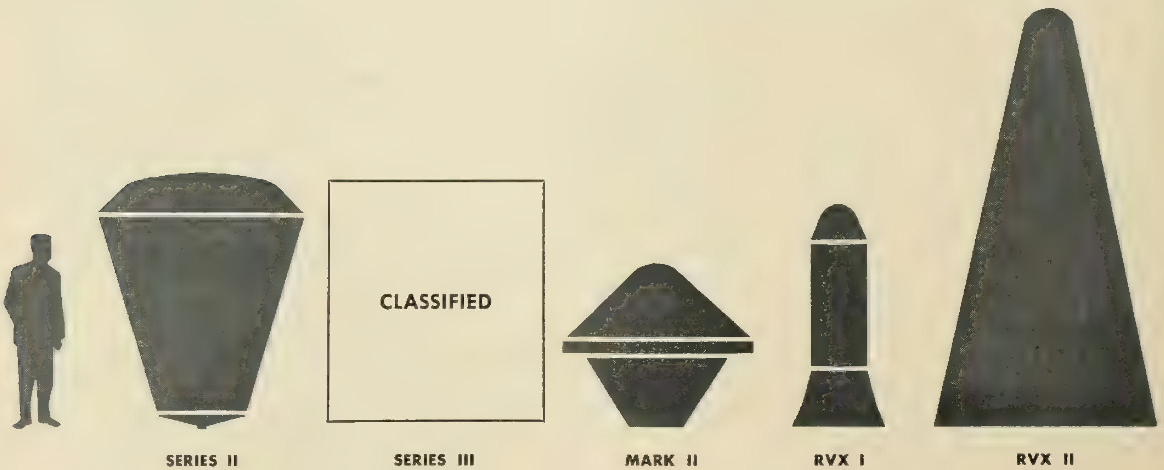
Both companies have developed ablation materials and heat-sink configurations which have been tested in the program. They have cooperated extensively on other phases of the work and several vehicles represent joint efforts.

• **Problems of re-entry design**—Re-entry—the final portion of a ballistic trajectory in which a long-range missile or satellite rips back into the atmosphere at speeds of 10,000 to 20,000 mph—obviously causes tremendous heating and structural loads. When the air becomes more and more dense, the particles of air start piling up ahead of the nose cone and the familiar shock wave appears.

Behind this shock wave, gas temperatures as high as 15,000°F or more are generated. Deceleration forces of 20-50 g's may be imposed on the vehicle as atmospheric drag increases. The duration of the heating and deceleration periods for ballistic missiles, entering as they do at fairly steep angles, is fairly short. In fact, the heat shock is almost explosive.

• **Basic designs**—The designer of nose cones has three objectives: to keep as much heat as possible out of the cone; to take what heat does exist and distribute it uniformly to prevent hot spots; and to select a material that can absorb the amount of heat required.

Several design techniques have been developed to handle the heat problem. One uses a material to absorb the neces-



BALLISTIC MISSILE RE-ENTRY VEHICLES. Air Force IRBM and ICBM re-entry vehicles which have been tested to date in research and development programs. Drawings are roughly to scale except for *Minuteman*, for which no dimensions are available. SERIES II (Avco) is a developmental heat-sink model for the second-stage *Titan*. MARK II (GE) is an operational heat-sink model for *Atlas*. SERIES III (Avco) is an operational heat-sink model for *Titan*. RVX-1 (GE/Avco) is an ablation material test model. Eight have been built and six flown, with two successful recoveries. RVX-2 (GE) is an ablation material test shape. RVX-3 (Avco) is an ablation test cone for Lot C *Titan*. Flown but not re-entered. Seven

sary heat in a straight-forward fashion —a heat sink. Another selects a material that will melt or vaporize. Heat is absorbed in the vaporization process and swept away in the air flow. This is known as ablation.

Heat may also be disposed of by radiation, transpiration, or film cooling. Several different techniques may be combined in a particular application.

The first two mentioned—heat-sink and ablation—have received the greatest attention and provide what appears to be the best solution for present-generation ballistic missiles.

• **ICBM complications**—The problems of designing a nose cone for an ICBM are much the same as for an IRBM except that temperatures and g-loading conditions are much greater for the larger, longer-range missile. In the IRBM, the peak temperatures reached are just beginning to become really difficult. For the ICBM the problems are much worse. As a rule of thumb, the heat flux increases as the cube of the velocity. Comparing a 10,000 mph re-entry with one of 15,000 mph shows that the heating rate of the ICBM nose cone can be more than three times that of an intermediate range missile.

Special rocket -test vehicles have been designed for ballistic flights of re-entry models. The Army developed the *Jupiter-C* which uses a 200-mile-range *Redstone* as a first stage and clustered solid-propellant rockets for the three upper stages. This combination was sufficiently powerful to hurl the scaled-down model of the *Jupiter* to actual IRBM re-entry velocities.

In the early stages of the Air Force ballistic missile program, use was made of the Lockheed *X-17* research vehicle. The final stage of the *X-17* was fired as the test nose cone shape fell back toward earth to accelerate it up to re-entry speed.

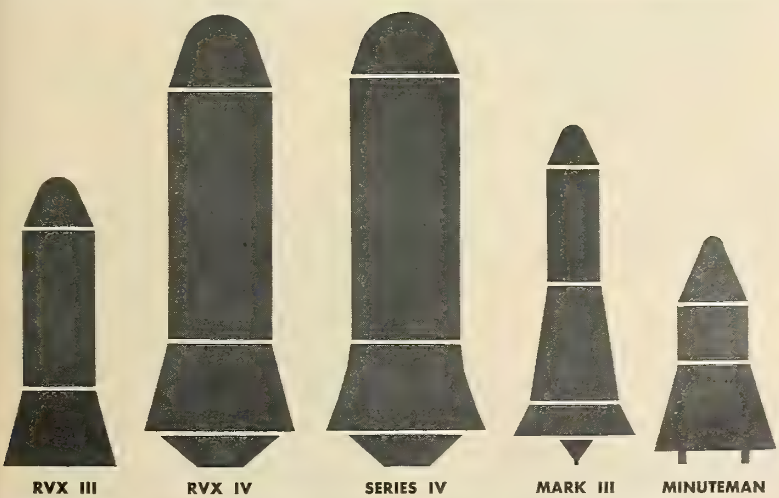
AEC Bought 7899 Tons of Uranium Oxide in July-Dec.

The Atomic Energy Commission bought 7899 tons of uranium oxide from 25 domestic processing plants in the last six months of 1959 at an average price of $8.79 per lb. of U_3O_8, a total of $139 million.

Domestic ore reserves were estimated to total 86,100,000 tons at the year's end. Ore stockpiles totaled 1,449,069 dry tons. Of this, 1,003,000 tons were held by private companies and 446,000 tons by the government. Private plants and government purchase depots received 3,614,000 dry tons in the six-month period, during which 3,623,000 tons of average grade 0.24% were fed to process.

The combined daily capacity of the 25 operating mills was 22,100 tons of ore per day. The only government-owned mill, at Monticello, Idaho, was closed at the end of the year.

About 65% of the nation's ore reserves are in New Mexico. Wyoming has about 18%. Most of the remainder is distributed through Utah, Colorado, Arizona, Washington, Oregon and Nevada.



built. RVX-4 (Avco) is a developmental model for Lot G *Titan*. Also flown on the *Atlas* (see cover, this issue). Eight have been built. SERIES IV (Avco) is a developmental and training vehicle for *Titan*, and a possible forerunner of an operational model. MARK III (GE) is an ablation type intended for the operational *Atlas*. MINUTEMAN (Avco) is a test shape used in range tests (not drawn to scale).

Sierra Metals to Build Big Vacuum-Melt Furnace

Sierra Metals Corp., Wheeling, Ill., will install one of the world's largest induction-heated vacuum melting furnaces.

Sierra, a subsidiary of American-Marietta Co., has ordered the furnace from the Vacuum Metallurgical Division of F. J. Stokes Corp., Philadelphia. It is expected to be installed by August and in operation by September.

The furnace is designed for volume production of Sierra's nickel and cobalt-base alloys, used for jet engine turbines and other high-temperature applications. It will have a nominal rated capacity of 4000 lb. at pressures in the range below one micron. With eight, 32-in. oil diffusion pumps, it will be one of the largest vacuum pumping systems ever built, Stokes said.

Sierra's new alloys have shown good properties at turbine temperatures higher than the present practical operating temperature, Stokes said. Turbine vanes and blades made from the alloys have been tested in experimental engines by Pratt & Whitney Division of United Aircraft Corp.

U.S. Borax Will Install 1300-ft. Conveyor Belt

A 1300-ft. mechanized conveyor system will be installed to provide increased flexibility and reduce costs at the big Boron, Calif., open-pit borate mine of the U.S. Borax & Chemical Corp.

The project is due to begin within a month and be completed in the fall. Trucks now haul the ore from the bottom of the pit 2½ miles to a surface crusher. The continuous-belt system will rise 315 ft. to the surface. The pit is 2000 ft. long, 1700 ft. wide and 275 ft. deep.

Trucking still will be used to transport ore from electrically operated shovels to a new hammer mill to be installed at the bottom end of the conveyor system.

Mercury Capsule Parachute To Be Woven by Stevens

The parachute that returns the Project *Mercury* astronaut's capsule to earth will be woven by J. P. Stevens & Co.

Radioplane Division of Northrop Corp. is producing the *Mercury* landing system under contract to McDonnell Aircraft Corp., prime contractor on the National Aeronautics and Space Administration project. The parachute will be of Ringsail, developed and produced by Radioplane from fabric woven by Stevens, the textile company said.

Data Cassette Recovered

This data cassette was recovered from the Atlantic Ocean after a successful flight in an Avco RVX-4 nose cone. The material research re-entry vehicle flew on a *Titan* Lot J missile over a 4385-nautical-mile range and ejected the cassette prior to impact at an altitude of 12,000 feet while traveling at 2500 feet per second (Mach 2.4).

The package contains a Cook Research Laboratory tape recorder which stored data during atmospheric re-entry. It records what happens to the long range missile cone as it reenters the earth's atmosphere and is subjected to temperatures of 12,000°F.

The cassette was recovered attached to a balloon which floats it after water impact. It was shot from the nose cone by small rockets. A skirted balloon cushioned its drop into the ocean. Signals from the capsule's radio antenna, a flashing beacon, luminous dye markers and shark repellent aided in locating the package 25 minutes after impact.

Cal Tech Radio Telescope Spots Space Radio Sources

Nine extra-galactic radio sources, ranging to one billion light years from the earth, have been located by a unique new twin radio telescope. This compares to five radio sources from other galaxies previously identified by all radio telescopes in the world up to the end of 1959.

The new instrument is part of the radio astronomy program of the office of Naval Research. It was built and is operated by California Institute of Technology under contract with ONR. It consists of two 90-foot parabolic antennas mounted on a 1600-foot-long east-west railroad track.

Working in tandem as a radio interferometer, the twin dishes produce a resolving power greater than any radio telescope in operation or under construction.

Cal Tech is now attempting to identify more than 100 extra-galactic radio sources which have been detected by various radio telescopes but not precisely located. Such extra-galactic sources are identified by correlating their direction from earth with visual observations made by optical telescopes. Some of these sources are so faint they are mere pin pricks of light on a photographic plate.

A north-south track will soon be added to the facility. By placing a radio dish on each track, the present fine resolving power will be significantly increased.

Westinghouse Develops 'Near-perfect' Amplifier

A small electronic tube developed at Westinghouse research laboratories reaches the near-ultimate in its ability to amplify ordinary light. The Astracon tube is so sensitive that it makes visible a single electron released at the tube's input by an individual photon—the smallest unit quantity of light that exists.

The tube operates on a unique amplifying principle discovered at Westinghouse five years ago. The image of an object, so dim that it is invisible to the naked eye, is focused by lenses onto a light-sensitive photosurface at the input end of the tube. The individual photons strike the surface and eject electrons from it.

By using five acceleration steps, a single electron is multiplied into about 3000. They are given a final 20,000-volt boost and aimed into a thin layer of fluorescent material at the output end. Here they release 20,000 or more photons of visible light. Thus, if the light striking the input photosurface is a dim, invisible image, the Astracon exactly reproduces that image on its output, thousands of times brighter.

EJECTED electrons in astracon tube crash into film to begin acceleration.

Study Reports on Likely Communications Satellites

The passive spherical reflector in a low-altitude orbit and the active repeater in a 24-hour orbit appear the most promising choices for communications satellites, according to a recent study by ITT Laboratories. Reporting on this study at the recent IRE Convention, L. Pollack and D. Campbell of ITT said that system engineering requirements determine the choice.

The low-altitude passive relay requires no electronic equipment and can be of simple lightweight construction. It can be launched with present boosters and tests have already perfected techniques for putting the "balloon" in orbit.

The passive reflector has almost unlimited bandwidth and can be used with a wide range of frequencies and power levels.

On the other side of the ledger, such a system has several disadvantages. For a given traffic channel capacity, it requires very high transmitter powers, large antennas, and extremely sensitive receivers. At its low altitude it will be in sight of only a relatively small area of the earth's surface.

Problems exist in acquisition and tracking and elaborate system coordination between stations is required. High transmitter powers will introduce severe interference problems.

The 24-hour active satellite overcomes almost all these problems. Its high altitude (22,000 miles) will make it visible over more than a third of the earth. Since it will be effectively "stationary," tracking will be no problem.

Low transmitter powers will be sufficient both on the ground and in the vehicle. Interference with other systems will be unlikely.

The active repeater has its own problems, however. It requires large booster vehicles, precise guidance and attitude control, and high component and system reliability. Definite bandwidth and peak power limitations will demand rigid control to prevent overload.

Ruled out in the study were low-flying repeater satellites such as Project *Score* which relayed a Christmas greeting from President Eisenhower to earth. This system provided storage and transmission of voice information and, according to some proponents, indicated feasibility of such a method. An improvement on this system will have a storage capacity of 12 million bits in each of five storage devices and will provide both real time and delayed re-transmission of the desired data.

Far IR Scanner Developed

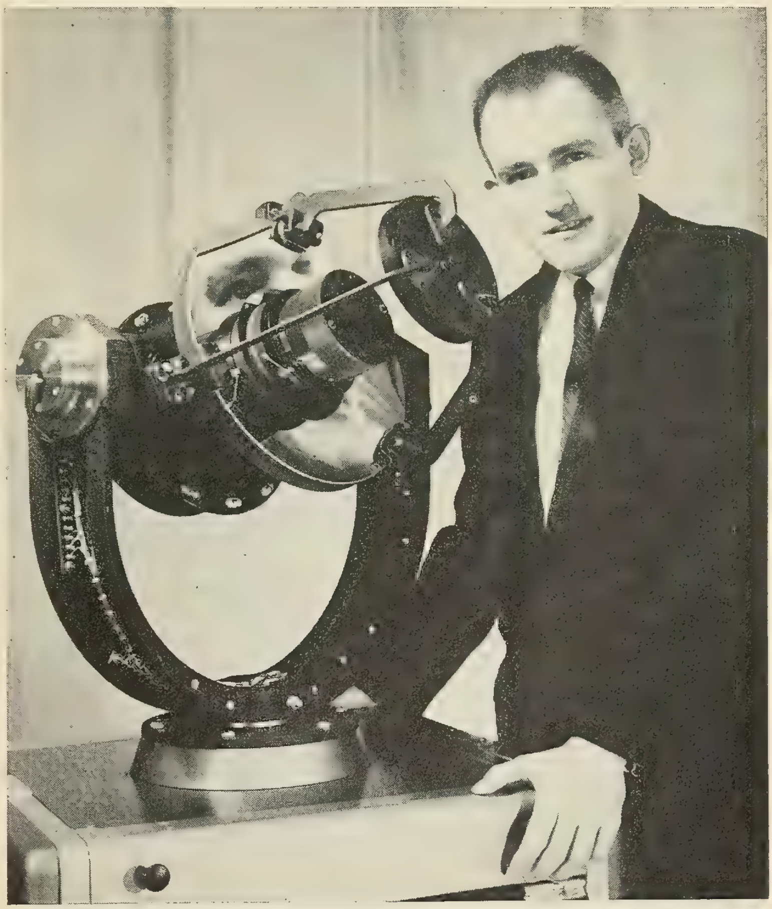
Development of a 50-pound gyroscopic far infrared scanner, adaptable for anti-ICBM missile guidance or interplanetary navigation, has been revealed by The Martin Co., Baltimore Division.

The new device permits detection of objects having very low temperatures such as the temperature of a satellite's outer skin surface. Its sensitivity enables it to distinguish between objects with small differences in temperature at distances in excess of the known current state of the art, the company said.

The scanner uses a 12-inch aperture and is equipped with an advanced optics system and a series of highly sensitive super-cooled detectors in combination with extremely low-noise amplifiers. Development of a new laboratory technique in crystal growth, according to Martin, has made it possible to combine relatively volatile elements with a single crystal of germanium in the detectors, thus permitting detection of "cool" far infrared radiation.

The entire scanner, including mirrors, detectors, and detector amplifier, can be rotated as an integral unit to create a gyroscopic effect. This will permit the device to remain stable during spins or turns of a rocket vehicle in which the scanner might be carried.

Designed for antimissile use, the unit can detect IR radiation emanating from an approaching enemy ICBM nose cone, distinguish this and decoys, and guide an antimissile missile to target intercept by means of a sensitive electromechanical system.



FAR INFRARED Gyroscopic Scanner is demonstrated by Irving E. Distelhorst, project engineer at Martin's Baltimore Division. The 50-lb. unit was displayed publicly for the first time at the recent IRE convention in New York. The gimbal support ring, mounted on a controls console, can rotate 360° on its vertical axis; the scanner and mirrors assembly can rotate 360° on a separate horizontal axis.

Are Big Conventions Worthwhile?

by Hal Gettings

NEW YORK—The annual Institute of Radio Engineers International Convention reached its peak this year, some observers feel. With its steadily increasing crowds, more and more exhibits, more lavish entertainment, and ever-rising costs, the huge technical meeting and exhibition is rapidly arriving at a point of diminishing returns for many participants.

One small company figures costs for the four-day affair as $20-25,000—and wonders whether it's worth it. Such an investment represents the profit on almost a million dollars worth of military business. Of course, some of the cost can be charged off to overhead, but a considerable investment is still represented.

Costs are easy to figure. Benefits are somewhat intangible and it is hard to put a dollar figure on them. But many companies are apparently taking a hard look at the investment and the expected return. Some drop out each year; many others feel they should but don't dare to. Still, there is always more demand for exhibit space than is available.

• **Swelling chorus**—Each year, the Convention is subject to much grumbling and criticism. This year it appeared to be even more widespread and vehement. Some of the beefs: The show is too big; it's hard for the small exhibitor to compete for attention with the larger, more spectacular displays and elaborate hospitality functions; costs are increasing; crowded conditions cause poor exposure; labor creates troubles.

• **"Featherbedding?"**—One of the biggest gripes is the labor situation. Almost all exhibitors complain of the exorbitant rates and "featherbedding" of the unions involved in handling and assembling the displays. Many felt that this year was much worse in this regard than ever before. Technically, a display can be put up by exhibitor personnel if no tools are necessary. The unions won't allow even this, however, and insist that their people do the work. Failure to comply results in immediate threats to close the show.

Such pressure, of course, has its desired effect; the reluctant exhibitor learns his lesson. Displays have a way of getting lost and work orders shuffled to the bottom of the pile.

One exhibitor complained that four of his people could set up their display in eight hours while it required six union assemblers 12 hours. And the work had to be done at premium weekend rates.

• **Boondoggle?**—There is no question that the show attracts engineers. Attendance this year was around 70,000 as compared to 60,000 in 1959. Many feel, however, that much of this engineering time could be better spent and that many engineers regard the show as purely a boondoggle—interesting, certainly, but often not really worth the time and money charged to the company footing the bill.

Many of the papers read in the technical sessions fail to reveal anything really new. Others are so poorly presented that it is difficult to dredge any significant information from them.

The crowds themselves are a source of irritation to the exhibitors. It's hard for the spectators to really see and evaluate the displays in the middle of jammed aisles with other spectators standing on their feet.

Bigness is a problem, too. Areas of interest of few manufacturers are broad enough to cover the spectrum of the IRE. Companies with products for specific and limited application—and these are many—feel they are paying for exposure to a large group of which only a small percentage can be classified as potential buyers.

• **Circuses**—Indicative, perhaps, of the sometimes oversold high technical level of the meeting is the low technical level of many of the displays that seem to attract the most attention. Mobs gather to watch such erudite exhibits as ball bearings jumping through hoops, a large dial indicating angle displacement, and a machine which dispenses free shoeshines.

Unquestionably, there are certain worthwhile benefits inherent in engineers getting together to see and hear new ideas and products. Such cross-fertilization has contributed greatly to progress. The question is whether the benefits are worth the candle.

In any case, such mammoth conventions as the International IRE and WESCON will probably continue to be popular and well-attended and bigger every year. Whether they will recognize their function as a means rather than and end—and serve this function is another question.

Possible Power for Future Spaceships

THIS LOCKHEED plasma accelerator produces thrust by ejecting ions and electrons at velocities of 220,000 mph. The possible forerunner of the first interplanetary space ship's propulsion system, the device produces the equivalent of two pounds of thrust.

Symposium Seeks Ways to Cut GSE Costs

by Paul Means

DETROIT—Principal speakers at the American Rocket Society's Ground Support Symposium here March 23-25 ranged in their talks from present missile and space problems to what type of equipment will be needed to support the moon bases of the future.

Main theme of the panel discussions was: How to reduce the cost of support equipment, which now accounts for two-thirds of the missile budget. Other information given included a description of the support for second-generation missiles such as *Minuteman, Polaris* and *Pershing*.

Dr. I. M. Levitt, Director of the Fels Planetarium of the Franklin Institute, and contributing editor of MISSILES & ROCKETS, described a detailed support system for a permanent moon base 20 years from now. He described how lunar rocks could provide the atmosphere and fuel for the base and how food could be derived from algae tanks.

Lunar structures and clothes, according to Levitt, would be fashioned out of synthetic fibers, and the first houses would be in lunar caves for maximum protection from space hazards.

Levitt predicted that man will have created a thriving civilization on the moon by the turn of the century.

Other comments by Levitt included:

• "The Russians have the capability to soft-land an instrument package on the moon today, and I would not be surprised if they did so this year. Such a package would weigh about 100 lbs."

• The Russian photograph of the back side of the moon taken by *Lunik II* is no fake, and bears out a theoretical picture he drew of it which first appeared in MISSILES & ROCKETS early last year. (See M/R, Feb. 16, 1959, p. 14.)

• The Russians will probably accomplish a manned lunar landing in 1966. Given a breakthrough on *Saturn*, the U.S. might also be able to do this by 1966.

• The moon is important as a launching base. Any nation which attempts to conduct its space program solely from earth "is courting suicide."

Dr. Homer Joe Stewart, Director of the NASA's Office of Program Planning and Evaluation, was not as optimistic as Dr. Levitt in his crystal ball gazing.

Stewart contended that many are too optimistic about what the U.S. can accomplish in space during the next few years, but not optimistic enough about what can be accomplished 15, 20 and 30 years from now.

He pointed out that our present capabilities in space are a long way from state-of-the-art. Of the 45 attempted satellite launchings of all U.S. organizations to date, Stewart estimated that only 14 were successful and three or four partly successful. This is the success ratio, according to Stewart, that the U.S. space program will be working with during the next few years.

• **Defense of variety**—Stewart also defended NASA's program of conducting research in a wide range of areas rather than concentrating on a few which might have more immediate and sensational results. The NASA program, he declared, is to place heavy emphasis on basic engineering techniques and equipment. By pushing development in all areas, and especially in the areas of vehicle development and space applications, Stewart predicts, the U.S. will be much further ahead in the long run.

Other comments made by Stewart included:

• Ground support equipment for space vehicles will be cheaper than it is for missiles, because re-use of the equipment lowers the overall cost.

• Industries doing space work will perform a great deal of research and development, but very little production.

• The ratio between engineers and production workers in space industries may become as high as three engineers for every production worker. In the missile industry presently there is approximately one engineer for every production worker.

• The lead time on a manned lunar space vehicle after completion of the booster will be about four to five years.

• **Military preserve**—Brig. Gen. A. W. Betts, Director of the Advanced Research Projects Agency, defended the viewpoint that there was a military space mission, and that the military

ARS meeting said to overlap others

Was the American Rocket Society's Ground Support Equipment Symposium worth while?

M/R asked this question of missile and space industry representatives attending the ARS' most recent meeting in Detroit.

The consensus was that though the Symposium was sometimes informative and generally interesting, it wasn't worth spending three days away from the job.

For those who did not have security clearance, only one panel discussion of any length was offered. Although the luncheon and dinner speakers were interesting and noteworthy from a news standpoint, most did not relay much technical information, and many did not relate their talks to present problems in the support equipment field.

The problem, as most observers saw it, is that there are too many organizations holding the same type of meetings in the missile and space field. The Institute of Electronic Engineers, holding a meeting at the same time as the ARS Ground Support Equipment Symposium, was conducting seminars into the same support equipment electronics problems. It was impossible to attend both meetings, and it raises the question as to whether both meetings are worth while.

General feeling of those attending the Detroit gathering seemed to be that while the ARS meeting was helpful in someways, it overlapped with meetings being conducted by other organizations in the missile field, and that some cooperation between professional organizations might do much to eliminate the problem. Joint meetings conducted by the ARS and IRE, the American Chemical Society, and others in areas where their interests overlap would eliminate many meetings, and heighten the value of those few meetings scheduled.

should have an active part in space research.

Betts did not believe it detrimental to the military space mission for NASA to build the early large boosters.

"I don't think anybody in the military would have said they should have developed the early supersonic aircraft rather than the old NACA," Betts said, "but if they had been denied the opportunity of modifying the NACA design for military purposes and carrying the work forward . . . then the military would have protested."

The initial military mission in space, according to Betts, is to "learn about it, and learn to use it to upgrade our military capability."

"The military has to be in the space business," Betts said, "but they don't have to build everything. When we see a specific need for a large booster, we will carry on from where NASA has developed it."

In the same vein, Betts predicted that NASA will get a great return out of ARPA's research in large solid propulsion systems.

Other remarks by Betts included:

• "The nation's missile and space missions have spread so fast and so rapidly that the government is supporting marginal companies . . . Time will shake these out as competition increases."

• "I believe strongly in the competitive bidding system."

• One reason for the Russian missile and space advantage is that they put their German rocket experts to better use during the late 40's and early 50's than the U.S. did, Betts said. The Von Braun team should have been used in the U.S.'s ICBM program.

• **Stressing balance**—C. S. Draper, head of the Department of Astronautics and Director of the Instrumentation Laboratory of the Massachusetts Institute of Technology, said that the balance between vehicle-borne equipment and ground support equipent will be one of the most important factors in determining the vehicle systems that will win the privilege of defending our country in this age of space.

Draper believes that missile support equipment should be light, simple, and moveable. He characterized the "hard" base as a sitting duck, and that an important factor of future missile units will be their flexibility and their transportability.

Draper warned against making missile support systems too complex and heavy. The goal, according to Draper, is a system where weight and bulk are "reduced to the point where even the highest-performance missiles could be serviced and provided with accurate guidance settings by mobile support equipment so flexible that it does not limit operations in any way."

Draper criticized the procedure where the complete vehicle is developed and then support equipment is designed to work with the existing vehicle. What usually happens, according to Draper, is that the equipment tests more components and functions than are strictly necessary. Adding to the problem is the necessity of having equipment to check the support equipment which in turn checks out the missile.

Draper recommended that support equipment be reduced to the simplest "go," "no go" and numerical identification type, and that no repairs be made in the field. Instead, "repairs might be made in factories or shops equipped with automatic check-out arrangements much more complex than the support equipment."

• **Closed sessions**—Of the four panel discussion sessions, three were classified "secret." These covered the problems encountered in actual field experience with currently deployed equipment; a review of second-generation missile ground support equipment; and current advances in mechanical and electrical ground support equipment.

One of the two non-classified sessions on Russian ground support equipment was cancelled. The other non-classified session was a summary of unusual chemical, transportation and legal risks involved in operation of the systems.

Brief summaries of the non-classified papers given at the Symposium and available from the American Rocket Society follow.

Operational Design—The Effect of Operational Concepts upon Weapon System Design. Peter B. Weiser, Space Technology Laboratories.

A summary of the maintenance, logistic, and personnel problems in firing missiles in the field which must be taken into consideration when the missile and its support equipment are designed.

Requirements and Trends in Standardization. Col. Thurston T. Paul, Army Ballistic Missile Agency.

A history of the efforts to standardize military support equipment, especially in electronics, instrumentations and communications, and the problems making standardization in some areas difficult.

Advanced Automatic Checkout Equipment. James Q. Maloy, Senior Program Manager, Bendix Support Equipment.

A review of present concepts in automatic checkout equipment, with specific emphasis on the "universal" and "adapter" module philosophies and applications.

How much Automaticity For Checkout Equipment? Sidney I. Firstman, the Rand Corporation.

An analysis of the virtues and faults of various types of programers with respect to the several design and operational features: malfunction detection and isolation; speed of test; control capability-versatility; self-test and verification; emergency shutdown capability; and reliability and maintainability.

Failure Prediction—A Method of Predetermining the Success or Failure of an Individual Missile. Allan T. Kneale, Motorola, Inc.

A definition of the function of ground support equipment with respect to the necessity of life prediction. The theoretical background required for a life prediction system is developed and a possible implementation is described.

Handling and Launching Considerations in Missile Design. by Michael L. Mastracci, American Machine and Foundry Co.

A presentation of the problems of designing handling and launching equipment around an already developed missile, and some suggested solutions.

Logistic Supply and Handling of Liquid Helium. John W. Marshall, Air Force Flight Test Center, Edwards AFB.

A proposal to have liquid helium available from a national supply systems, and some suggestions as to how this can be accomplished.

Use of Standard Vehicles for Missile Ground Support Equipment. Peter L. James, Missile Division.

A proposal to cut down the high cost of support equipment by using existing military vehicles instead of specialized vehicles, and examples of how this was done in the case of *Redstone's* support equipment.

Legal Aspects of Missile Handling. G. Vernon Leopold, chairman, Special Committee on Space Law, State Bar of Michigan.

A discussion of the legal problems connected with injury or damage due to negligence of inadvertent accidents in the handling and transporting of missiles.

Chemical Hazards in Handling Rocket Propellants. Alfred J. Zaehringer, American Rocket Company.

A review of chemical hazards in terms of overall systems. All chemical propellants are treated.

Transportation and Handling of the Saturn *Booster. Julian S. Hamilton,* Army Ballistic Missile Agency.

A review of the plan to transport the *Saturn* booster to Cape Canaveral by river barge.

Handling of Large Rocket Engines. Stanley R. Parker, Rocketdyne, North American Aviation, Inc.

A discussion of rocket engine handling problems and the host of factors to be considered in the development of a handling equipment system serving large rocket engines from their inception to their use at remote test sites.

Low-Altitude Exploration Stressed

Britain's workhorse Skylark sounding rocket will be given longer range; U.K. satellite program will use Black Knight for testing

by G. V. E. Thompson

LONDON—A great deal of exploration still must be done under the 125-mile altitude attained by satellites, cautions Sir Harrie Massey, British scientific space expert.

At the Royal Aeronautical Society symposium on upper atmosphere and space research, Massey emphasized the importance of vertical sounding rockets below the usual satellite altitude.

Most experiments of the lower altitudes have been carried on by the principal British sounding rocket, the *Skylark*. The first large solid rocket to be used for upper atmosphere research, the rocket weighs 2550 lb. at launch. It is made up of the 2200-lb. Raven rocket motor, 100-lb. nose structure, 100-lb. fins and 150-lb. payload.

The motor was designed by the Rocket Propulsion Establishment (RPE), Wescott, who was also responsible for installing the 1800-lb. propellant. The Royal Ordnance Factory, Waltham Cross, produces the propellant, which contains ammonium picrate, ammonium perchlorate and polyisobutylene. It has a specific impulse of 177 sec. and is case bondable. Cases are made by Bristol-Aerojet. Raven can exert a thrust of 12,000 lb. for about 30 sec.

Skylark is launched from a tall tower to minimize dispersion. The roll rate of the rocket is kept as low as possible, since it tends towards instability near the end of burning as a result of roll resonance.

Skylark has carried a wide range of experiments, including magnetometers, ion probes, cameras, grenades, sodium vapour ejection, photometers, etc. Data is usually transmitted by a 465 mc/s. telemetry system, although if necessary the payload can be recovered by a parachute.

The range of the rocket is expected to be increased in the near future. A new three-axis stabilized platform will be introduced, using a gyroscopic reference system in conjunction with stabilizing air jets of 5 lb. thrust, maintaining control within 2 or 3 degrees. A new high-thrust booster will be fitted to the vehicle, increasing its ceiling to 120-130 miles. Named Cuckoo (it kicks the Raven out of its nest), it will burn for about 4 sec. and develop a total impulse of 81,000 lb-sec. Cuckoo and Raven cost about $2000 and $8500 respectively.

• **British satellite**—At the same meeting, experiments in space physics proposed for the U.K. satellite program were outlined.

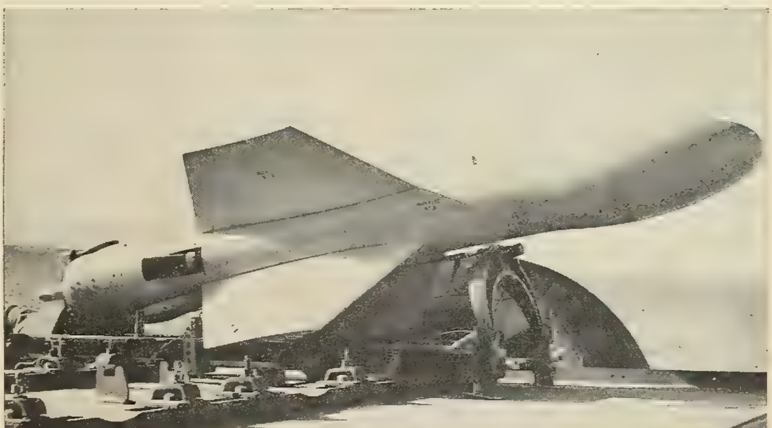
Black Knight (Saunders-Roe) is expected to be used for some experiments, including sphere drop tests to determine air density above 100 km. The instruments being developed for the Anglo-American *Scout* satellite would first be tested in *Black Knight*.

Design studies for an all-British launcher were discussed, calling for a de Havilland *Blue Streak* topped by a modified Saunders-Roe *Black Knight* (the propellant tanks would be less elongated). This combination would give the required altitude and orbital velocity, but rather than relight *Black Knight* to apply the final burst to put the payload into orbit, it is proposed to incorporate a third-stage rocket with vernier motors of 500-1000 lb. thrust. Since it would be fired before the cutoff of the *Black Knight*, there would be no coasting to final altitude; the third stage would rise under a continuous low thrust. This was thought to offer better opportunities for correcting the course and to provide some saving in weight.

One possible source of trouble would be the bumping of the third stage by the separated *Black Knight*, because of outgassing of propellants in the latter. This phenomenon of residual thrust spoiled one of the *Explorer* launchings and has been observed in trials of *Black Knight* at Woomera.

The launcher could place in orbit a payload large enough to include the fully stabilized platform necessary for some of the astronomical experiments; 1750 lb. could be placed in a circular orbit at 300 miles altitude, or 200 lb. in an elliptical orbit (perigee 300-apogee 100,000 miles).

French Antitank Weapon



NORD AVIATION'S new *SS 12* is reported to have a 4-mile-plus range, more than twice that of the *SS 11*. The antitank weapon can be launched by infantrymen, from tanks, light aircraft or helicopters. Overall length is about 6 ft., weight about 150 lbs. and guidance is either wire or radio controlled. Nord expects to put the *SS 12* into mass production within 14 months at its plant near Chatillon, France.

Future Red Rockets To Aid In Forecasting

Instruments in future Soviet rockets launched toward the sun and around the earth will be designed with an eye to long-range weather forecasting, according to recent reports from Soviet journals.

A great deal of work is being done at the Crimean observatory to prepare for experiments in identifying the particles emanating from the Sun and in solving the problem of the earth's corona. The laboratory reports success in simulating "solar flashes" through compression of magnetic fields of extremely high intensity.

Earth satellites will carry special light, photo, and television equipment to report on various meteorological processes. The Soviets hope to investigate the matter of shifts in the geographic pole which they believe affects these processes. Other experiments will explore the effect of solar radiation energy and heat exchange in the atmosphere, and the relationship between the build-up of the Siberian anticyclone in winter and geographic pole shift. (*Literaturnaya gazeta*, Jan. 23, and *Sovetskaya aviatsiya*, Feb. 9.)

German Rocket Men Will Hear U.S. Papers

The German Society for Rocket Engineering and Space Flight Research will hold its 12th annual meeting at Heidelberg, May 23-25, with Prof. Dr. Eugen Saenger presiding.

Work of several top U.S. scientists will be represented among the approximately 20 papers to be presented. Drs. E. R. Roberts of Aerojet-General Corp., Geissler and Gerathewohl of Army Ballistic Missile Agency will be contributors.

The 8th "Hermann-Oberth Medal for Outstanding Merits in Astronautical Research" will be awarded at the session. It is expected that the constitutional session of the Advisory Space Flight Committee at the German Federal Ministry of Traffic also will be held this time.

Pneumatic Steering

LONDON—A pneumatic apparatus for steering a guided missile has been developed here by T. J. Dorricott and C. L. Paice of Pye, Ltd.

The apparatus swivels an extension to the rocket venturi. Gas pressure is bled from the combustion chamber and used to operate pistons disposed symmetrically around the venturi axis. The invention is covered by British Patent Specification 827,299.

soviet affairs

By DR. ALBERT PARRY

U.S. short-range missiles . . .

are the subject of a special series of four articles in *Krasnaya Zvezda*, the foremost dáily of the Soviet armed forces. Appearing on January 19 and 28 and February 9 and 18, the series was done (apparently on assignment) by four specialists, three of them officers of the Red engineering troops, and the fourth a nonmilitary expert: Lt. Cols. V. Kruchinin and N. Avilov, Maj. V. Zhukov, and Engineer L. Giagzhnas. The first three are Russians; the civilian may be a Lithuanian. The American missiles they discuss are the *Honest John*, the *Corporal*, the *Redstone*, and the *Mace*. A subtitle of each of the four articles states that the authors gleaned their information from Western literature. The content of the series shows that U.S. journals were the main source, but that some West European channels were also utilized. The articles carry diagrams and other pen-and-ink illustrations clearly of Western origin.

Considerable respect . . .

for American-made tactical missiles is manifested by the Soviet authors' selection of Western comments. Thus Kruchinin stresses Western opinion that nonguided missiles such as the *Honest John* can shoot further and have heavier warheads than conventional artillery. He also points out that the *Honest John* weighs less than an American atomic gun "while on the move" and that the missile "can be equipped with the same nuclear warhead as can the gun's shell."

On the negative side . . .

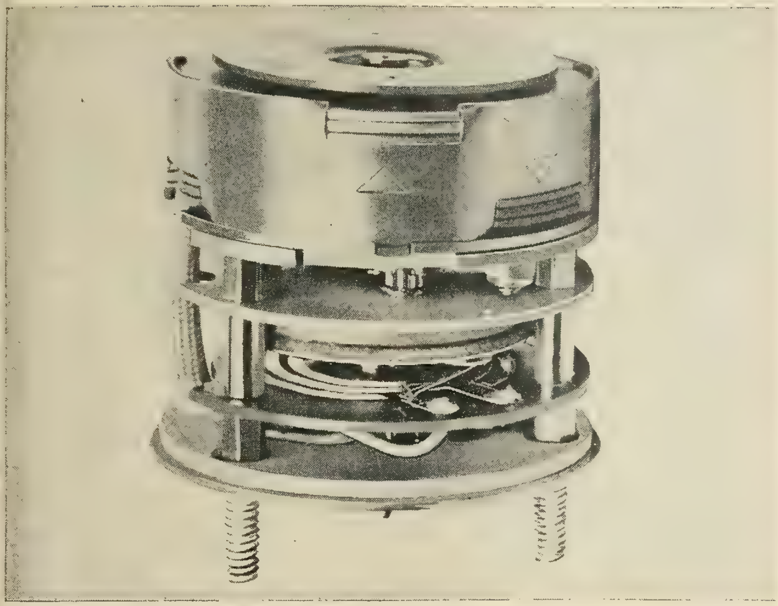
more briefly, Kruchinin records the Western consensus that nonguided missiles are less precise than conventional artillery in reaching their targets and that they can't be fired as rapidly—in other words, that these missiles cannot be sent to the enemy lines in a veritable barrage typical of conventional artillery shells. In describing the liquid fueling systems of the *Corporal* and the *Redstone*, Kruchinin observes that this fuel requires special equipment and exact handling, which "complicates the exploitation" of these missiles. Giagzhnas, while praising the *Mace*, enumerates several of what he calls its deficiencies, among them the fact that it can be rather easily spotted by the foe, "as its guidance equipment emanates electromagnetic energy."

Actual handling . . .

of U.S. tactical missiles during maneuvers approximating actual combat conditions is discussed in detail by Zhukov. His article is supplemented by particularly graphic illustrations, based no doubt on American sources. Some French and Swiss sources are used in the last article of the series, by Avilov, on the Western family of antitank guided missiles. He concludes by saying that "the introduction of antitank guided missiles into the military business is due to high combat qualities of such weapons." At the same time, he quotes approvingly Western statements to the effect that this innovation does not mean the abandonment of other antitank weapons.

No comparison . . .

with Soviet tactical missiles is even hinted at in any of the four articles. But a careful study of this series by our experts could reveal just what in our short-range weapons attracts the Red specialists—just where they deem our weapons to be on a par with theirs, and where we may possibly be either behind or ahead.



Stepping Devices Feature Accuracy

A line (series 18400) of compact stepping devices which can perform high speed sequencing, pulse control and switching functions has been introduced by the A. W. Haydon Company.

Characteristics of the new units include low power consumption and extreme reliability. The rotary stepping switches, pulse dividers and precision sequencers can in many cases replace conventional solenoid or relay-actuated units. Stepping action is achieved magnetically, without ratchets, linkages or contacts.

Printed circuit rotary stepper switches contain up to 30 positions on a single deck. Each pulse cycle advances these switches one position. They can be operated continuously or at random intervals to produce up to 2400 steps per minute, at 24 volts DC. Optional motor control circuits can provide for "home to reference" by self stepping or with 60 CPS external power supply. With power off, switches are magnetically locked. Optional shaft extensions can be provided for manual override of the magnetic detent. Stepper switches are available with solder terminal headers, AN connectors and hermetic sealing.

Precision gated stepping switches can serve as pulse dividers for random or variable pulse sources or as frequency dividers when the pulse source is constant. Units can be factory-set to produce output pulses in any desired proportion to input, i.e., for 100 pulses fed into the unit, 1 pulse is sent out.

Circle No. 225 on Subscriber Service Card.

Two-Frequency Heating Unit

A dual frequency 10 KW output high-frequency induction heating unit (Model LI-10D-1) operating at approximately 400 KC and 4 MC is being offered by Lindberg Engineering Co.

This unit has been specially designed for research and development work and for production of semiconductor and other conductive materials.

The unit has a totally enclosed cabinet with a gasketed door for dust and fume protection. Outside dimensions of the cabinet are 40 in. wide by 40 in. deep by 76 in. high with a 30 in. x 30 in. x 16 in. (approx.) cubicle mounted on top for dual frequency requirement. The entire unit is mounted on heavy channel iron skids, and overhead cross members are available for lifting. Net weight of the entire unit is approximately 2150 pounds.

Power input is 230/460 volts, 3 phase, 60 cycles. Other voltages and frequencies can be supplied. Power consumption is 20 KVA maximum at 90% power factor. Power for the type 6420 water-cooled oscillator tube is obtained from six industrial type 575-A mercury vapor rectifier tubes employed in a 3 phase, full wave rectification system. Filament voltages are automatically controlled through constant voltage transformers to maintain proper tube filament voltages regardless of line voltage fluctuations.

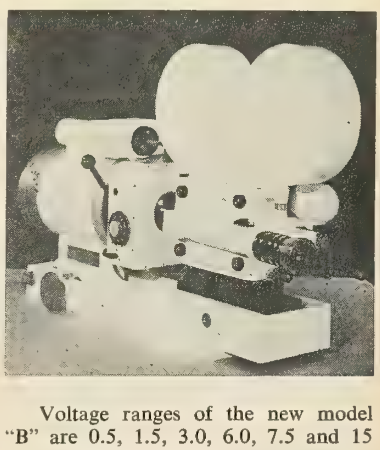
A type 6420 water-cooled, industrial tube is employed in an extremely stable tuned plate circuit. Maximum oscillator tube life is assured by conservative use under proper operating conditions. Filament voltage is automatically controlled through a voltage regulating transformer. In the 400 KC circuit the water-cooled, hermetically sealed tank capacitor contains a low loss high frequency liquid dielectric. In the 4 MC circuit the tank capacitors are low loss heavy duty industrial type vacuum capacitors.

Output power is available at two different frequencies (approximately 4 MC and 400 KC) from two separate sets of output terminals. One terminal of each frequency pair is at ground potential. Internal adjustments can be made on the respective tank circuit to match a variety of work coils.

Circle No. 226 on Subscriber Service Card.

Sensitive Volt-Ammeter

A model of the Hermach-Engelhard Transfer Volt-Ammeter for ranges not covered by the earlier version has been introduced by the Instruments and Systems Division of Engelhard Industries, Inc. Both units are for precision measurement of alternating voltages and currents between 5 and 50,000 cycles per second with an accuracy within 0.05%.



Voltage ranges of the new model "B" are 0.5, 1.5, 3.0, 6.0, 7.5 and 15 volts, while current ranges may be set at 7.5, 25, 50 or 100 milliamperes. Comparable ranges on the Model "A" are 15, 30, 75, 150 and 300 volts, and

100, 250, 500 milliamperes, 1.0, 2.5, and 5.0 amperes. Instruments of this high precision and versatility have heretofore been unavailable; the wide ranges of these meters make them particularly useful in the aircraft and missile fields.

A major application for both models is in standards laboratories for the original calibration and later checking of other instruments. Engelhard can also furnish, at extra cost, a certificate from the National Bureau of Standards, if desired by purchasers of either model.

Operating principle is the comparison of heating effects of an unknown alternating current with an accurately adjusted direct current, which can then be measured directly with any good null potentiometer. Internal mercury cells provide the DC source. Balancing of the AC and DC heating effects also employs the null principle for utmost accuracy.

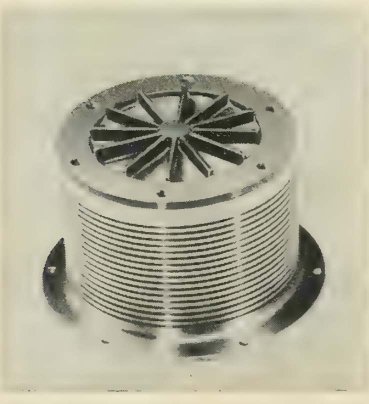
A 5%, direct reading rectifier-type meter is incorporated in the instrument to indicate approximate values of voltage and current. This indicates the approximate setting for the potentiometer and also serves as a range checker to prevent accidental burnout of the thermo-element. The thermal converter element, in turn, can be simply replaced without necessitating recalibration or affecting accuracy of the meter.

Circle No. 227 on Subscriber Service Card.

LOX Pressure Equalizers

Hydrodyne Corp. is producing a line of pressure equalizers for use with LOX and other fluid tanks wherever there is a pressure differential.

This particular equalizer incorporates the principle and materials of Hydrodyne's machined aluminum bellows. Its design resembles a top hat with the end cap of machined aluminum, nickel-plated, and strengthened with ribbing soldered thereto. The bellows, which is hermetically sealed, will take three quarters of an inch minimum stroke at 70 psi. Temperature range is from –400°F to 750°F.



The bellows section is machined from various aluminum, nickel and other high-strength and high-temperature alloys. The particular method of machining this bellows permits a "controlled wall thickness"—concentrating thickness or strength where needed. Failures are eliminated due to fatigue, with some of these having been tested to 100,000,000 cycles without failure.

These units are available for pressures up to 4000 psi. Current sizes are from ¼ in. to 36 inches in diameter.

Circle No. 228 on Subscriber Service Card.

Aluminum Alloy Tool

A tool that performs a wide variety of milling, drilling and tapping operations on cast aluminum alloy missile wings at a rate of 17 pieces per hour at 100% efficiency has been designed and built by Snyder Corporation.

The unit is a line-index type in which the missile wing is clamped in a fixture and traversed on hardened and ground ways to various machining positions. In completing the machining of the part, the work fixture is moved by a hydraulic cylinder arrangement along a 68-in.-long path.

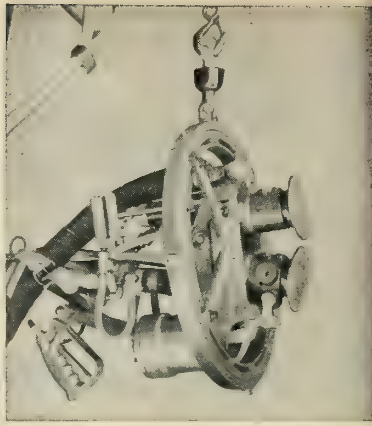
The tool has a welded steel base to which are bolted welded bases, arms and columns for several different types of moving and fixed machining units. The fixture is located by shot pins for machining operations in intermediate positions and by stops at each end of the travel. Some machining operations are carried out while the fixture is being indexed from one fixed position to the next.

Eleven different machining operations are performed at five fixture positions on the missile wing by an assortment of machining units including a Snyder standard way-type unit, two air-powered motorized drilling units, two motorized three-spindle drill heads, a two-spindle motorized tapping unit, nine motorized precision spindles, four air-powered, air-fed single-spindle drilling units and three air-powered, air-fed lead screw single-spindle tapping units.

Circle No. 229 on Subscriber Service Card.

Roll Spot Welder

A Portable Roll Spot Welder, especially designed to weld three thicknesses of metal which require high clamping pressure, is now being produced by the newly-consolidated Progressive Welder and Machine Company.



The machine is patterned after Progressive's single-drive Roll Spot Welder, except that the new unit has synchronized, double-wheel, air motor drive. Unusual strength and clamping pressures up to 1000 pounds are attainable, and its compact design and light weight permit efficient production speeds of up to 250 inches per minute.

The portable welder is applicable for use on cumbersome jobs such as automotive roof panels, deck lid openings, and wheel housings. Spot frequency is adjustable between ½" and 1½" automatic spacing, and two or three thicknesses of .032 sheet are not only easily handled, but present a much improved appearance.

The synchronized, special alloy drive and contact rollers are available in various diameters to meet work requirements. They turn on special, current-carrying needlebearings to withstand the high clamping pressures and to assure long service life and minimum maintenance under high production usage.

Circle No. 230 on Subscriber Service Card.

Smallest Sealed Switch

The KLIXON AT1-1 ("aspirin tablet") Precision Switch establishes a a miniaturization record for hermetically sealed switch design. Weighing less than 1/28th oz., it is also the lightest switch of its type on the market. The KLIXON AT1-1 is 95% smaller and weighs 93% less than the KLIXON KX Series hermetically sealed switches.

Size reduction is made possible by use of a unique, snap-acting, "W-blade" element, a design which lends itself to miniaturization. The envelope dimensions of the AT1-1 are 0.320 in. diameter by 0.440 in. long.

This subminiature switch has been especially designed for applications which require a true hermetically sealed unit of the smallest and lightest

configuration possible, combined with high reliability for aircraft, missile and electronic uses.

The hermetic sealing is accomplished by applying the techniques of seam and stitch welding to switch assembly. Welding eliminates solder flux contamination and contributes to miniaturization by requiring less volume for the weld than for solder. Terminals are brought out through a fused glass seal to make the assembly completely environment-free. Casing is stainless steel.

Prior to being hermetically sealed, the precision calibrated switch is filled with a dry, inert gas to ensure reliability for dry circuit applications.

Exacting tolerances on tiny detail parts are kept by the use of Swiss Screw Machines.

Current capacity is 3 amperes, 28 volts dc, resistive. Ambient temperature range is −65°F to +275°F. Other specifications include: contact arrangement, S.P.D.T.; 10,000 cycle life min.; resistance to 40 g's vibration and 100

g's shock; overtravel, 0.003 in. min.; movement differential, approx. 0.002 in.; pretravel, 0.005 in. Actuating force is 12 ozs. ± 8 ozs. and release force, 1 oz. min.

Circle No. 231 on Subscriber Service Card.

New Literature

POLYCARBONATE RESIN. Mobay Products Co. has published a new Technical Information Bulletin describing the physical and electrical properties of its polycarbonate resin, "Merlon," a new thermoplastic for engineering applications. The Bulletin compares Merlon with seven other plastics to show its unusual combination of characteristics which makes it suitable for engineering applications now far beyond the range of present materials. The resin, a linear aromatic polyester of carbonic acid, now is being evaluated for applications in the electrical, automotive, lighting, general industrial, graphic arts and engineering fields. A few of these applications include switchboard connectors, coil forms, relay bases, printed circuit card holders, safety helmets, drafting film, and heat resistant diffusion lenses.

Circle No. 200 on Subscriber Service Card.

STEEL CORROSION. Cobalt additions to chromium stainless steels have a favorable effect on their resistance to corrosion, say researchers of the Cobalt Information Center. The influence of cobalt additions on the structure of the mechanical and chemical properties of ferritic and austenitic stainless steels is being studied at the Centre National de Recherches Metallurgiques, Liege, under the sponsorship of the Centre d'Information du Cobalt. First results of this investigation are now available in a report entitled, "The Corrosion Resistance of Some Stainless Steels Alloyed with Cobalt," published in the fifth issue of *Cobalt*. Stainless steels investigated contained 17 and 27 per cent chromium and had nickel contents of 0, 2, and 9½ per cent. Cobalt additions ranged from 1.5 to 10 per cent. Tests were made by total immersion in sulfuric acid, intensiostatic and potentiostatic methods of electrochemical testing, and for susceptibility to intergranular corrosion after heat treatment. The first tests confirmed that cobalt increases corrosion resistance in acid solutions; after appropriate heat treatments, the cobalt-alloyed steels were less susceptible to intergranular corrosion.

Circle No. 201 on Subscriber Service Card.

SEMICONDUCTORS. An eight-page technical newsletter published by International Rectifier Corporation contains a four-page article entitled "Properties of Semiconductor Devices Affecting Voltage Division," in which voltage distribution and various methods to achieve equality are discussed, analyzed, and recommendations made for the solution of specific problems.

Circle No. 202 on Subscriber Service Card.

SILICA AEROGEL. Monsanto Chemical Company's Inorganic Chemicals Division has announced the publication of a new technical bulletin on Santocel A, a silica Aerogel used for thermal insulation. This product, through its unique structure, gains an amazingly low thermal conductivity, which is less than the theoretical value for "still" air, Monsanto said. The bulletin contains product descriptions covering chemical, physical and structural properties, in addition to shipping and handling notes and suggestions as to use.

Circle No. 203 on Subscriber Service Card.

SUPPORT EQUIPMENT. An illustrated four-page brochure describing the capabilities of the GSE Systems Div. of Adler Electronics, Inc. for design and manufacture of production-line to pre-flight missile and satellite checkout systems is available.

Circle No. 204 on Subscriber Service Card.

GROUND SUPPORT. An illustrated brochure containing photographs and descriptions of ground support equipment for the *Redstone*, *Jupiter*, and other missiles is available from Designers for Industry, Inc. In addition to GSE produced by DFI, various Frequency Standards and Programmers are illustrated and specifications given.

Circle No. 205 on Subscriber Service Card.

HYDRAULIC RELIEF VALVES. In-line hydraulic relief valve, type 415745, weighing less than 8 ozs., is manufactured to MIL-V-5523B. The new line features full reverse flow and surpasses specification crack and re-seat requirements. All-hardened steel moving parts are used in the valve, thereby eliminating sliding "O"-ring seals. An integrated fluid dash pot and a velocity-sensitive poppet are responsible for absolute stability, exceptionally flat performance and virtually no discernible hysteresis. The type 415745 configuration conforms to MS-28887. A smaller external configuration is available. Operating temperature is from −65°F to 275°F. Gladden Products Corp.

Circle No. 206 on Subscriber Service Card.

STEEL CASTINGS. The use of steel castings in the defense industry is featured in a new booklet published by the Steel Founders' Society of America. Entitled "Sinews of Modern Living," the 28-page booklet dramatically presents the multitude of uses for steel castings. Line drawings of more than 200 representative steel castings, selected from over 1000 photographs and references are contained in the booklet. In addition to the section devoted to the use of steel castings in the defense industry, the booklet also explains and illustrates the use of cast steel parts and components in these particular fields; railroad, utilities, machine tool, construction and construction equipment, petroleum, mining, forestry and materials handling.

Circle No. 207 on Subscriber Service Card.

GLOSSARY. Standard Wire and Cable Company has published a pocket-sized "Glossary of Wire and Cable Terms." The booklet lists alphabetically common terms, expressions and units used in the electrical wire and cable industry. It is very handy as a reference to engineers, designers, technicians and purchasing personnel.

Circle No. 208 on Subscriber Service Card.

$2 Million More For *Minuteman*:

Boeing Airplane Co. will centralize electronic systems work for the *Minuteman* ICBM ground support equipment in a specially equipped building now undergoing a $2 million renovation program. Formerly used for B-70 developmental work, the Boeing Field site will have over 17,000 sq. ft. of "clean" area with precise temperature and humidity control. It will be the largest controlled environment facility owned by Boeing and among the largest in industry.

Test and bench equipment is to be checked out in early June. Operations will begin later in the month. By July 1, Boeing expects to have over 150 employes assigned to the new area on *Minuteman* work.

TEFLON FACILITY PLANNED: Tri-Point Plastics Inc. plans a 15,000 sq. foot plant to process "Teflon" fluorocarbon resins exclusively. It will be adjacent to the firms existing building in Albertson, N. Y.

NEW MILITARY PRODUCTS DIVISION: A new Military Products Division to work exclusively on defense products has been created by Bausch & Lomb Optical Co.

Heads of departments are: sales, J. W. Wright; manufacturing, C. N. Hendershott; research and engineering, Dr. L. S. Packer. Herron Optical Co., a B & L subsidiary, will be utilized by the new division.

The divisions will work with both government and prime contractors, and do extensive work in the field of integrated optical-mechanical-electronic systems.

GOOD-ALL ACQUIRED: Thompson Ramo Wooldridge Inc. has concluded an agreement to acquire controlling interest of Good-All Mfg. Co., Ogallala, Nebraska, manufacturers of electronic components. More than 80% of Good-All stock would be acquired through exchange of TRW common stock. Good-All, with 1127 employes, holds a minority interest in Radio Kenmetal, Inc., part of which was acquired last year by TRW when the latter bought control of Radio Industries, Inc., Des Plaines, Ill. Milam Electric Mfg. Co., Providence, R.I., is a Good-All subsidiary which produces plastic-laminate materials for electrical insulation.

ENGLISH EXCHANGE: English Electric Valve Co. Ltd., England and Eitel McCullough Inc. U.S.A. have agreed to exchange technical information and manufacturing know-how on klystrons, travelling wave tubes and power tubes.

DOUGLAS REALIGNS: The Thermodynamics Section of Douglas Aircraft's Missiles and Space Systems Engineering division has been re-named Thermodynamics and Nuclear Science Section in keeping with a realignment of the group's efforts. A communications systems section has been established also in Missiles and Space Systems Engineering to work in such areas as electronic countermeasures, counter-countermeasures, integrated command-function communications and decoy discrimination.

EIA Chief Honored

AT BOARD of Directors Meeting of Electronic Industries Association in Washington recently, H. Leslie Hoffman (left) chairman of EIA Awards Committee, and Leslie F. Muter, EIA treasurer and past president, congratulate EIA President David R. Hull on his selection to receive the Association's 1960 Medal of Honor.

financial news

• **Lear, Inc.**—Lear, Inc. reports a 50% increase over 1958 in 1959 net earnings.

Net income of $2,407,022 in 1959 topped $1,607,751 in 1958. Shipments of $87,002,497 were 37% over the previous year's volume of $63,627,475. New business brought in a record $100,800,000 in new orders. Year end backlog of $76,000,000 compared with $71,900,000 at 1958 year end.

• **Thompson Ramo Wooldridge**—Sales hit a new high of $417.7 million. The missile electronics and space category accounted for $167 million of this, over an $89 million total for the category in 1958. TRW's semiconductor subsidiary, Pacific Semiconductors, Inc. doubled sales in 1959.

• **Bell & Howell**—Net income amounted to $3.4 million with sales of $61.2 million. Combined 1959 sales of Bell & Howell and Consolidated Electrodynamics Corp. (CEC) recently merged, were $105 million—net earnings $5 million.

• **General Precision Equipment Corp.**—Sales reached 28% over 1958, with a total $215.6 million Net income was $4.2 million.

• **Temco Aircraft Corp.**—Sales of $100.7 million fell under 1958's total of $119 million. Earnings of $1.2 million were also under the 1958 total of $2.6 million. Missiles and electronics accounted for 27% of sales.

• **Ionics, Inc.**—Ionics pulled out of a loss year in 1958 of $16,128 with a net profit in 1959 of $83,188.

—when and where—

APRIL

Solar Energy Symposium, American Society of Mechanical Engineers, and Mechanical Engineering Dept., University of Florida, Gainesville, April 4-5.

1960 Nuclear Congress: "What will the future development of nuclear energy demand from engineers?" includes 6th Nuclear Engineering and Science Conference; 8th NICB Atomic Energy in Industry Conference; 6th International Atomic Exposition, New York Coliseum, April 4-7.

Society of Automotive Engineers, National Aeronautical Meeting and Missile and Aircraft Engineering Display, Commodore Hotel, New York, April 4-8.

American Chemical Society, 137th National Meeting, Cleveland, April 5-14.

American Rocket Society, Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif., April 6-8.

1960 National Meeting "Hyper-environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, April 6-8.

Royal Aeronautical Society, Coventry Branch, "The Optimum Size of Rocket Engines," Coventry, England, April 7.

Society of Instrument Technology, "The Electronic Computer as a Unit in an Automatic Data-Processing System for Missile Trials," Overheu, London, April 7.

ASME-SAM Management Engineering Conference, Statler-Hilton Hotel, New York City, April 7-8.

IRE and ARS, Southern Ohio, Fourteenth Annual Spring Technical Conference, Hotel Alms, Cincinnati, April 12-13.

British Institution of Radio Engineers, Computer Group, London, April 13.

International Symposium on Active Networks and Feedback Systems, sponsored by Polytechnic Institute of Brooklyn, Dept. of Defense Research Agencies, Institute of Radio Engineers, Engineering Societies Bldg., New York City, April 19-21.

Society of Plastics Engineers, North Texas Section, Annual Regional Technical Conference, Hotel Texas, Fort Worth, April 20.

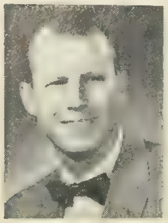
Symposium on Electrical Conductivity in Organic Solids, Air Force Office of Scientific, Research and Office of Naval Research, Duke University, Durham, N.C., April 20-22.

Royal Aeronautical Society, "On Reducing Costs of Space Research," London, April 21.

Southwest Metals & Minerals Conference, "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles, April 21-22.

American Ceramic Society, 62nd Annual Meeting, Bellevue Stratford Hotel, Philadelphia, April 24-28.

James A. Gibson: Named manager-communication and navigation systems engineering of General Electric's Light Military Electronics Dept. Formerly supervisor - radio guidance and instrumentation systems, he succeeds **W. J. Kuehl,** promoted to manager - engineering. Gibson joined GE in 1950 and transferred in 1953 to LMED, where he continued to work on airborne search radar until assigned as project engineer on *Atlas* radio guidance.


GIBSON

Sven H. Dodington: Promoted to technical director-government projects at International Telephone and Telegraph Corporation Laboratories. Will continue as vice president and director of the Avionics laboratory.

Fred M. Kinney: Former manager of industrial sales, Vickers Electric Products Division of Sperry-Rand Corp., joins Good-All Electric Mfg. Co. as chief engineer of the Electrical-Mechanical Division.

Jack B. Gilbert: Appointed quality control manager, *Titan* fabrication, at The Martin Co.'s Denver Division, responsible for procurement and receiving, planning, fabrication and test laboratory functions. Prior to joining the division in February, 1960, held positions with Republic Aviation Corp. and Boeing Airplane Co.


GILBERT

Dr. Howard R. Hegbar: Formerly manager of Avionics and Electronics Engineering Division, Goodyear Aircraft Corp., appointed assistant chief engineer. Also serves as a member of the company's forward planning and development committee and is a member of NASA's research advisory committee on control, guidance and navigation.

Robert Englert: Joins the components division of Telemeter Magnetics, Inc., as applications engineer. Was formerly western manager of field engineering for Telecomputing Corp., and prior to that with Western Electric Co.

Lt. Cmdr. Linwood L. Leftwich (USN, Ret.): Resigns as vice president of Feedback Controls, Inc. Prior to joining the firm, served as project officer, Guided Missile Test Instrumentation Systems, Bureau of Aeronautics, where he was responsible for the development of the AN/FPS-16 missile and satellite tracking radar.

W. Harold Edmunds: Former chief engineer of the small circuit breaker division, I-T-E Circuit Breaker Co., named manager succeeding **William P. Bolger,** now manager of the special products division.

Robert M. Wood: Former plant manager for the Semiconductors Division of Sylvania Electric Products, joins Pacific Semiconductors, Inc. as manager of the transistor plant; **David M. Edwards** has been selected as manager of planning and control.

S. E. Danyow: Formerly general manager of The Talco Engineering Co. operations at Falcon Field, appointed vice president, Rocket and Ballistic Operations of Rocket Power-Talco Div. of The Gabriel Co. Previous posts: Aerodynamic design at Boeing Airplane Co.; aeronautical research at the University of Michigan Research Center and engineering supervisory work at Ogden Air Material Area Headquarters.


DANYOW

Edward O. Johnson: Appointed chief engineer at RCA's Semiconductor and Materials Division. Joined the firm in 1948 and has served as manager high-temperature product development, Materials Division, and manager, advanced development. Holder of 12 patents.

Capt. Sheldon Brown, USN (Ret.): Named assistant manager of Aerojet-General Corp.'s Atlantic Division. Formerly served as consultant to the general planning staff of All American Engineering Co.

Dr. John A. Snover: Appointed to the research and development laboratory staff of Metal Hydrides Inc. and **V. Anthony Cammarota,** former research chemist at Gulf Research and Development Co., appointed to the metallurgical group.

Samuel Feinstein: Elected manager of the Applied Research Laboratory of Servomechanisms, Inc.'s Research Division. Before joining the firm in 1947, was associated with the Fairchild Camera and Instrument Corp., where his work included designs for automatic tracking systems for radar and the Fairchild Navigational Star Follower.


FEINSTEIN

Raymond S. Stewart: Named government liaison engineer for Texas Instruments Inc., Metals & Controls division and TI's subsidiary, M & C Nuclear, Inc. Was previously senior project engineer in charge of commercial products development at M & C Nuclear, Inc.

John A. Swint: Former president of Vard, Inc., elected director of operations for the Ogden Division of The Marquardt Corp., in charge of manufacturing, plant engineering, industrial relations and security.

Gerard R. Selg: Joins the technical staff of Electro-Optical Systems, Inc., as a member of the fluid physics division and will be responsible for the design of control circuits and instrumentation for ion propulsion motors. Previous posts: Electrical development engineer at Aerojet-General Corp.; electrical design engineer for Lockheed Aircraft Corp.

James D. Burns, also joins the firms energy research division, where he will be concerned with analytical investigations of power systems for space application. Was previously engaged in missile systems analysis on radar and infrared tracking systems at Hughes Aircraft Co.

Jack T. Cairns: Former director of sales, Daystrom Pacific Division, appointed manager, customer relations, Precision Power Division, American Electronics, Inc.

Lee Adams: Former manager of Electric Circuits, Inc., joins Curtiss-Wright Corp. as manager of its new etched circuit department. Earlier posts: Supervisor of manufacturing engineering and quality control at Graphik - Circuits; production supervisor and manufacturing engineer, U.S. Chemical Milling Corp. and head of the etched circuit department at Amelco.


ADAMS

A. F. Beale, Jr.: Elected director of research for Dowell Division of Dow Chemical, succeeding **Dr. W. W. Love** now research consultant.

W. C. Purple, Jr.: Formerly production manager named to the newly created post of vice president-production at Melpar, Inc. a subsidiary of Westinghouse Air Brake Co.

Dr. Frank E. Swatek: Joins American Electronics, Inc., American Laboratories Division, in the newly created position of staff consultant.

Joseph G. Neuland: Appointed to the

new post of southwest district field engineering manager for the Systems Division of Beckman Instruments, Inc. Was a member of the field engineering staff and is a former manager of systems engineering.

Burton M. Kuck: Appointed senior project engineer at Kinetics Corp. Was formerly with Bell Telephone Laboratories, specializing in military communications system design and underwater sound development.

KUCK

Stanley Abkowitz: Elected manager-refractory metal product development of Kelsey-Hayes Co., Metals Division, responsible for development of new products for ultrahigh-temperature service. Previous posts: Plastics engineer, Foster Grant Co.; materials engineer, Watertown Arsenal, staff metallurgist, Mallory-Sharon Metals Corp. Holds five patents on titanium alloys.

Eugene Dowd: Former general sales manager of Markite Products Corp., elected president of the newly established Bowmar Pacific, Inc., a subsidiary of Bowmar Instrument Corp.

Seymour Weiner: Advanced from product planning manager to product engineering department head at Sperry Semiconductor Division of Sperry Rand Corp.

Leonard S. Hermelin: Joins Emerson Radio and Phonograph Corp. as vice president of engineering and manufacturing for the Government Electronics Division. Was formerly with Republic Aviation Corp.

Robert V. Johnson: Formerly with Lenkurt Electric Co., appointed manager of applications engineering in the Equipment Division of Levinthal Electronic Products, subsidiary of Radiation Inc.

John B. Hamre: Formerly divisional sales manager, appointed director of sales for the Electronics Division of The Gabriel Co.

H. S. "Penny" Bellue: Former vice president of Hughes Aircraft Co.'s Products Group, joins Osborne Electronic Sales Corp., as vice president in charge of marketing.

Carl R. Jardine: Joins Aeronutronic, a division of Ford Motor Co., as manager of computer components, Computer Operations Marketing, responsible for the marketing of BIAX memory and logic devices, digital components, memory drums and devices. Was formerly with Burroughs Corp. as manager of Defense Marketing for the western U.S.

NASA

$100,000—**Hydromatics, Inc.**, Livingston, N.J., for valve parts for use in developing the interplanetary rocket "Nova."

NAVY

General Dynamics Corp.'s Electric Boat Division, Groton, Conn., for plans and design services for a fleet ballistic missile submarine. Amount not disclosed.

Solar Aircraft Co., San Diego, for fabrication of rocket motor cases for new *Eagle* missile. Amount not disclosed.

$47,099,934—**Puget Sound Bridge and Drydock Co.**, subsidiary of **Lockheed Aircraft Corp.**, for construction of three guided missile destroyers.

AIR FORCE

Cook Electric Co., Chicago., for conducting a study of performance and aerodynamic deceleration devices at high mach and high altitude. Amount not disclosed.

$273,000,000—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for continued research and development on the *Discoverer*, *Midas* and *Samos* satellites. (Three contracts.)

$3,000,000—**Hughes Aircraft Co.**, Culver City, Calif., for manufacture of 79 single sideband receiver units. Subcontract from **Philco Communications Div.**

$2,000,000—**Reynold Electrical and Engineering Co., Inc.**, and **Fischbach and Moore, Inc.**, Los Angeles, for electrical work on three *Titan* missile launching complexes at Ellsworth AFB.

$700,000—**Boeing Airplane Co.**, Wichita, for B-52/*GAM-87A* weapon system development program

$400,000—**Yardney Electric Corp.**, New York City, for manufacture of Silvercel batteries.

$231,000—**Avien, Inc.**, Woodside, N.Y. for manufacture of timers and transmitters for use in fuel and temperature measurement systems.

$230,355—**North American Aviation**, Los Angeles, for rocket package spares in support of F86, D, F aircraft

$125,000—**Aeronca Manufacturing Corp.**, for study of launching and ground support complex associated with the operations and maintenance of manned and unmanned space systems.

$95,000—**Cleveland Pneumatic Industries, Instrumentation & Control Div.**, Grand Rapids, Mich., for developing a "sky hook landing gear" capable of orbiting space vehicles for landing a space ship on the moon.

ARMY

$4,672,467—**North American Aviation, Rocketdyne Div.**, Canoga Park, Calif., for design and development of motors. (Three contracts.)

$3,000,000—**The Martin Co.**, Orlando, for an antiaircraft defense system patterned after the missile master system.

$666,982—**Chrysler Corp.**, Detroit, for continuation of engineering services on the *Redstone* missile program.

$354,800—**McDonald Contractors, Inc.**, Los Angeles, for G/M test shop, components at Edwards AFB.

$300,000—**American Missile Products Co., Inc.**, Lawndale, Calif., for flight telemetering equipment on the *Sergeant*. Subcontract from **Jet Propulsion Laboratory**.

$298,772—**Gilfillan Bros. Inc.**, Los Angeles, for engineering services related to *Corporal* missile system. (Two contracts.)

$261,000—**Firestone Tire & Rubber Co.**, Los Angeles, for guided missile, XM2E1.

$200,000—**Ryan Aeronautical Co.**, San Diego, for XM-21 target missile flight service program.

$135,640—**Cubic Corp.**, San Diego, for fabrication, installation and check out of electronic trajectory measuring system.

$100,000—**RS Electronic Corp.**, Palo Alto, a subsidiary of **Regan Industries, Inc.**, for design and production of automatic systems to test electronic controls of the RP-76 rocket target missile. Subcontract from **Radioplane Div., of Northrop Corp.**

MISCELLANEOUS

$75,000—**Hermes Electronics Co.**, Cambridge, Mass., for study and development of a satellite digital program and storage system to be used in the *Transit* satellite navigation system. Subcontract from **Applied Physics Laboratory, Johns-Hopkins University.**

BIDS

Purchasing and Contracting Div., White Sands Missile Range, N. Mexico: Antenna range tower-north, project consists of construction of wood fabricated antenna tower with appurtenances—Job—IFB RD-29-040-60-198—Bid opening 19 April '60. Bid sets available 5 April '60 unless previously exhausted.

Central Procurement Div., U.S. Army Support Center, Chicago, 1660 E. Hyde Park Blvd., Chicago 15, Ill. Installation of telephone cables and terminals at Nike site MSP 70, St. Bonifacius, Minn.—Job—IFB AV-11-175-60-12—Bid opening 7 April '60.

Purchasing Dept. Naval Supply Depot, Newport, R.I. Oscillograph, thirty-six channel, Minneapolis-Honeywell, visicorder or equal with Heiland series M galvanometers or equal, delivery desired 20 June '60—1 each—IFB 298-181-60B—Bid opening 19 April '60.

Warner Robins Air Material Area, Robins Air Force Base, Ga., Attn: Director of Procurement and Production. Tape, magnetic: compatible, for use on UNIVAC file computer model I and UNIVAC IAW purc desc—700 reels—IFB 09-603-60-77B, local purchase—Bid opening 8 April '60.

U.S. Army Engineer District, Pittsburgh Corps of Engineers, New Federal Building, Pittsburgh, Pa. Construction of support facilities, missile master, Pittsburgh defense area, Collier Township, Allegheny County, Pa. Bid sets available after 22 Mar. '60. Non-refundable $10.00 charge for set of specs and dwgs. Completion 380 calendar days—Job—IFB ENG-36-058-60-21B—Bid opening on or about 28 April '60.

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reviews

AIR TECHNICAL DICTIONARY, (German-English)—Duell, Sloan & Pearce, New York. $10.

Experts from the various fields of German aviation research and development have compiled a dictionary of essential terms relevant to each field.

AERODYNAMIC PHENOMENA IN STELLAR ATMOSPHERES—A BIBLIOGRAPHY, Boulder Labs, NBS. Order PB 151389 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 95 pp., $1.25.

Prepared for the use of aerodynamicists participating in the Fourth Symposium on Cosmical Gas Dynamics, the bibliography covers material giving specific information on an inference or a theory of aerodynamic motions in the stellar atmosphere.

FUNDAMENTALS OF STRESS ANALYSIS, Albert Deyarmond and Albert Arslan, Los Angeles, Aero Publishers, 256 pp., $5.75.

This is the Second Edition of a text that discusses classical strength of materials adequately and applies the techniques to solving typical aircraft stress problems. The work is on an elementary level and for this reason would be good for an aircraft designer trying to refresh his memory about stress problems, or for recent college students who wish to apply to practical problems that which they have already learned academically.

Advanced techniques such as the analysis of indeterminate structures, flutter, and effects of elevated temperatures and fatigue are only casually mentioned or not touched on at all.

ROCKET PROPELLANT HANDBOOK, Boris Kit and Douglas S. Evered, Macmillan, New York, 354 pp., $12.50.

Here, for the first time, is a complete, unclassified survey of rocket propellants. It is bound to become a standard reference, needed by every library in the industry. It seems also to be wholly suitable as a college text.

The authors have reported on the general characteristics, physical and chemical properties, storage and handling methods and performance characteristics of almost 100 chemicals used as propellant ingredients.

In a three-chapter opening section, the basic principles and the fundamental equations of propulsion are detailed, after which a chapter apiece is devoted to liquid and solid propellants.

The major portion is divided into inorganic and organic propellants, rather than by application. The chapter on each chemical states whether it is useful in solids or liquids, or as fuel, oxidizer or monopropellant.

The inorganic section includes chapters on aluminum, ammonia, beryllium, boron and boron compounds, fluorine and related compounds, hydrazine and hydrazine hydrate, hydrogen, hydrogen peroxide, lithium and lithium hydride, mixed acid, inorganic nitrates, nitric acid, nitrogen oxides, oxygen and ozone, perchlorates, water.

The organic section includes chapters on alcohols and ethers, amines, aromatic hydrocarbons, metal organic compounds, nitroparaffins, organic nitrates, petroleum fractions, polymers, saturated hydrocarbons, unsaturated hydrocarbons, miscellaneous organic propellants.

A concluding section discusses properties of the pressurizing gases, air, helium and nitrogen.

Both authors were with the Missile Division, North American Aviation, at the time they worked on the book, and others at North American checked the manuscript. Kit is now head of the Physics and Chemistry Program at the Air Information Division of the Library of Congress, while Evered is head of market requirements at Hughes Aircraft Co.

THEORY OF MECHANICAL VIBRATION, Kin N. Tong, New York, John Wiley & Sons, 348 pp., $9.75.

Simply written, this text explains modern techniques of vibration analysis as painlessly as a good teacher can. The book is called "advanced" because it treats the conventional problems from the modern viewpoint that its students know some mathematics and that there are such things as digital computers. This is a commendable attitude because so many textbook writers continue to assume that no engineering student has gone beyond integral calculus, and that the slide rule is the only computing device around.

The text is admittedly "theory centered," with engineering applications coming in only as illustrations of method. It treats the theory of linear mechanical vibrations.

Topics that receive special attention are: principle of superposition, eigenvalue problem in matrix, differential and integral equations, and energy methods.

The Divorce of STL and the Air Force

Sometime within the coming months the Air Force must come up with a substitute for its unique relationship with Space Technology Laboratories, the captive systems engineering corporation which managed the development and production of the first U.S. intercontinental ballistic missile.

Two paths are open and the Air Force is not looking at either happily.

The Air Force can organize another corporation, hoping to eliminate the factors which made STL unpopular.

Or, the Air Force can try to build up a technical capability within its own ranks.

If the USAF sets up "Corporation A," now under consideration, it must recruit scientists and engineers from industry, possibly many from STL itself.

If the USAF takes the in-house road it must build up a competent task force from a relatively small nucleus within itself—a nucleus which, Cinderella-like, has occupied the C-Ring chimney corner of the Pentagon for many years.

Manpower will be the problem in either case: finding it, holding it and inspiring it.

STL is a group of scientists and engineers organized to handle systems engineering for the Air Force, working for and with the Ballistic Missile Division.

STL is also a private corporation working for profit—and the profit it made for its incorporators was quite handsome. It stepped on a number of industrial toes and their cries of pain reached Congress. It is a congressional mandate which forces the Air Force divorce from STL. Whether this disunion is for better or worse is debatable, and many of the points on either side are highly emotional.

Actually, in the present climate of the nation's missile/space program, it is probably just as well that STL be severed from the USAF and join the normal competitive industrial companies.

STL was formed when we had just achieved a breakthrough which permitted packaging a hydrogen warhead within the thrust capability we could foresee in an intercontinental ballistic missile. We knew the Russians were concentrating on a similar weapon. It was recognizably imperative to our national safety that our ICBM be produced in the shortest possible time.

Working together so closely that it is difficult now for the members of either organization to separate their activities and credits, STL and BMD achieved a miracle of modern systems engineering to come up with the ICBM 18 months ahead of the schedule laid down for them.

Hundreds of corporations were called upon to contribute the genius and skills which went into the missile. It was the job of STL to so integrate these skills and this genius that the production miracle could be accomplished. The team had few precedents—they set their own. A thousand technical problems they solved as they went along. They cut corners and red tape, they devised and improvised—and they got the job done.

Many things contributed to their success. They had a priority on manpower and money. They had great leadership which inspired enthusiasm. They had the knowledge of a tremendous need. They were imbued with a sense of urgency.

Today the urgency and enthusiasm is gone from the nation's missile/space program. We have politics and business as usual. Even STL's leaders admit the old combination probably couldn't duplicate the miracle of the ICBM now.

What the Air Force will come up with as a substitute we haven't any idea. But we hope it will be good enough to at least help perform the second miracle which will be necessary to catch Russia in space—when some administration gets around to calling for it.

Clarke Newlon

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April 11, 1960

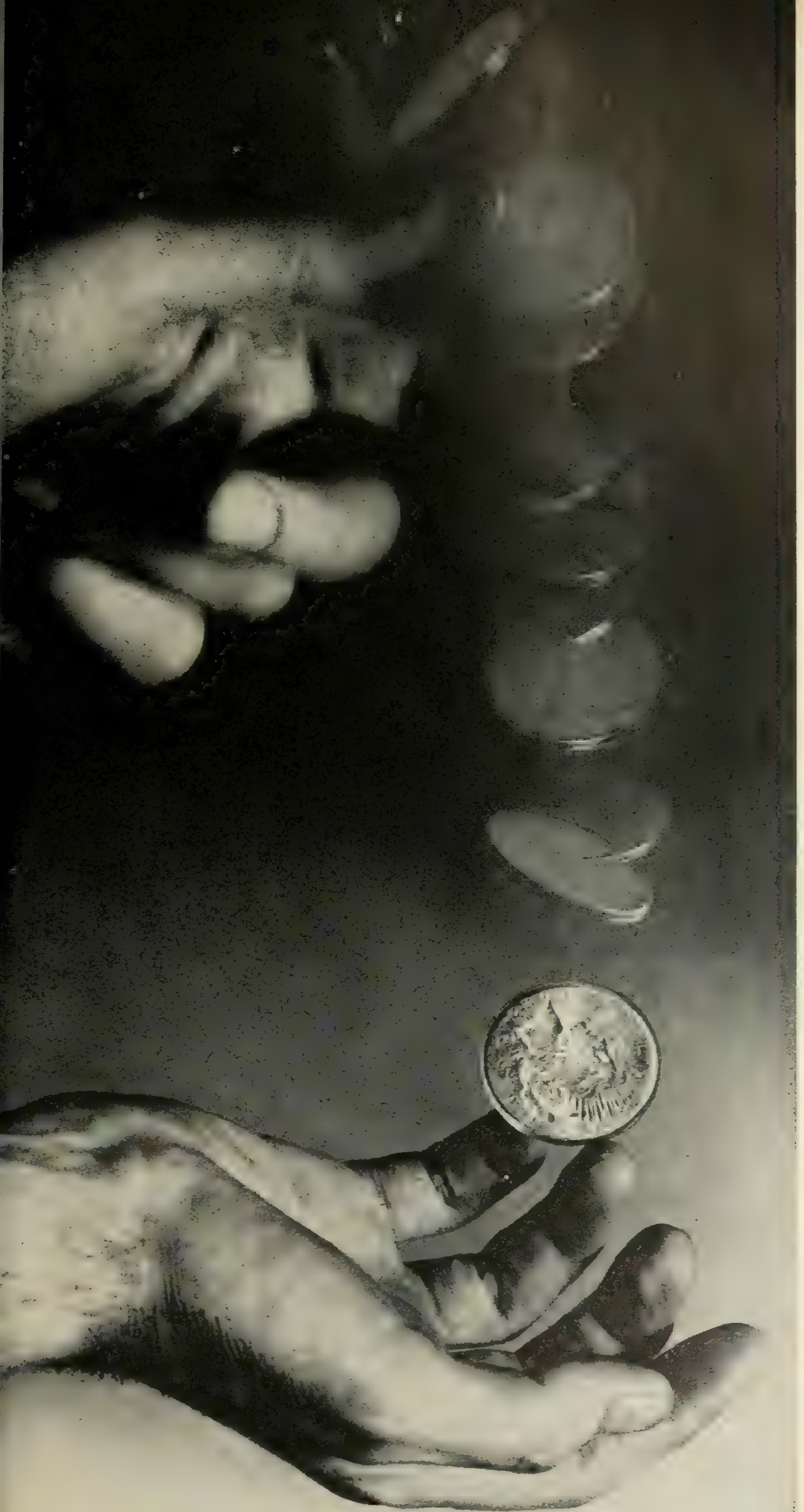
missiles and rockets

THE MISSILE/SPACE WEEKLY

Polaris Spurs ASW Program

New M/R Department: ASW Engineering . . . 36

AN AMERICAN AVIATION PUBLICATION



He took the luck out of heads or tails

This AMF engineer had a delicate problem: to accomplish the separation of the expended stages of a multi-stage rocket. If separation occurs too soon, thrust in the nearly burned out stage may exceed the aerodynamic drag, the tail overtakes the head, and...boom. A million dollar collision and no insurance.

His solution: An acceleration switch that turns the burned out stage loose at the right split second ...a switch that makes rockets think for themselves.

His switch is compact. It is designed to work in any missile at any range with any payload. It is ingeniously simple in conception, design, and operation. A spring is attached to a free swinging hammer, the spring force acting to pull the hammer against the contact plate. At calibration the spring can be set to oppose any G from 1 to 100. When the missile is launched, the hammer is held back by the acceleration forces until the stage decays to the desired separation G. When the spring force overcomes the forces of acceleration, the hammer comes forward, strikes the contact plate, and the circuit required to make separation is closed automatically. No guesswork, no luck, no *collision.*

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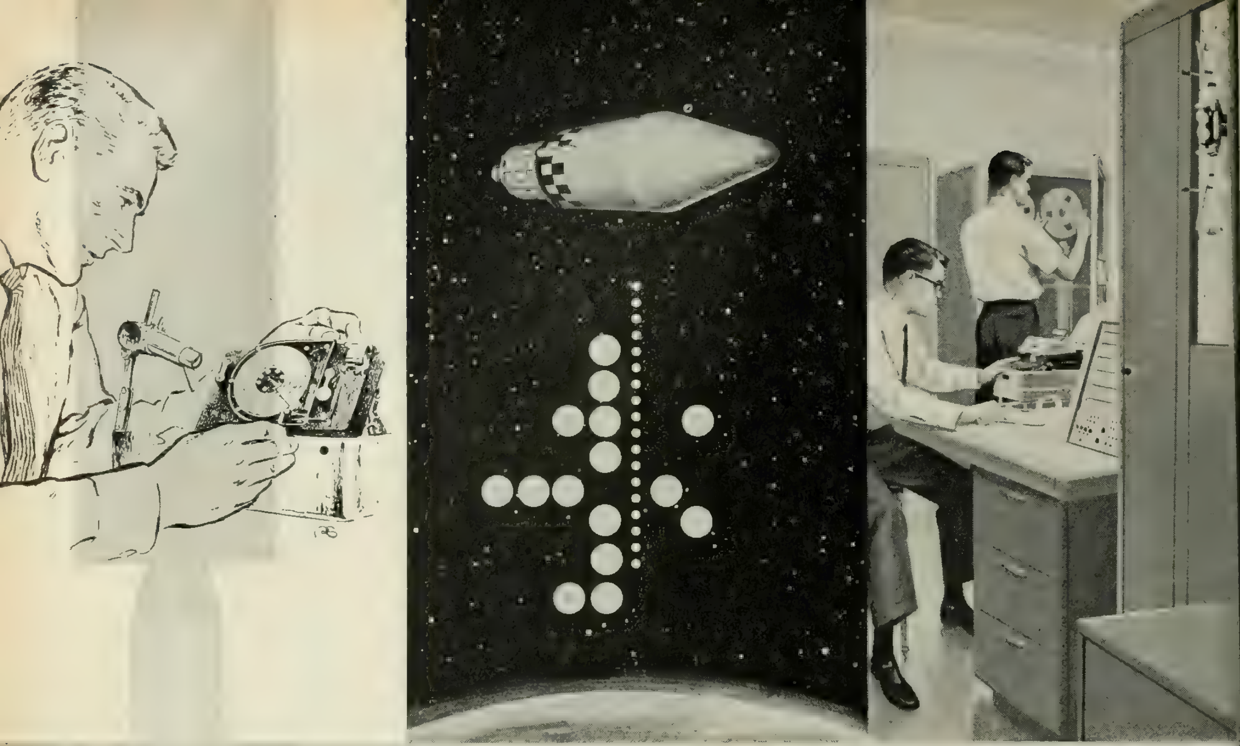

THE MISSILE/SPACE WEEKLY
missiles and rockets

April 11, 1960 Volume 6 No. 14

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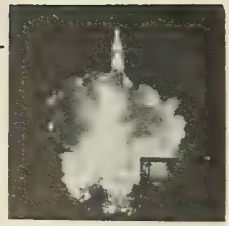
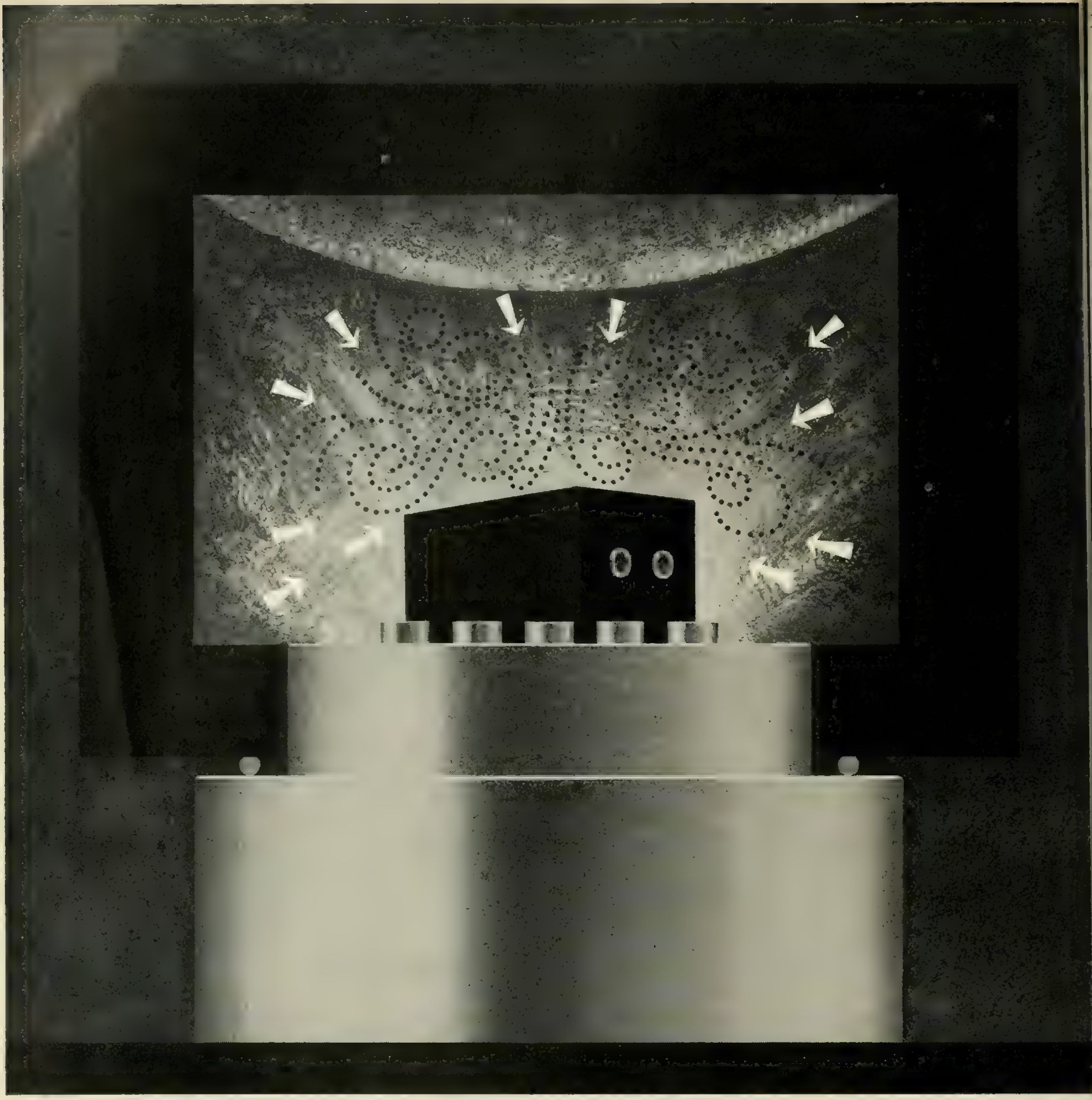
THE COVER



Sub-launched missiles—does U.S. have a defense against them? (See p. 36.) Polaris is shown rising from ship motion simulator just before rocket motors ignited.

31,400 copies this issue



letters

Heaviest Load?

To the Editor:

Page 15 of the Feb. 29, 1960, issue has a paragraph about heavy objects on pneumatic tires. In 1955 a B-36 successfully took off and later landed with a gross weight in excess of the 350,000-pound weight you are citing as the heaviest. I am not sure of the details, but I believe the gross at take-off was 410,000 pounds and the landing was completed after only one circle of the field. Bear in mind, I don't wish to claim that the B-36 was the heaviest thing on pneumatic tires, but it was heavier than your example.

Stanley V. Castner
The Marquardt Corporation
16555 Saticoy Street
Van Nuys, Calif.

Better Look Up 'Archaic'

To the Editor:

The March 7, 1960, issue of M/R had on its front page, "Threading-New Twist for Solids," and on page 36, "Buttress Threading Cuts Case Weight."

I am sure the Russians must be laughing at the latest attempts to fool them.

It is hard to conceive that archaic methods of threading are in use in the solid rocket program.

George E. Barnhart
Flight Path Control Co.
2228 East New York Drive
Altadena, Calif.

April in Paris

To the Editor:

Our attention has been called to a story appearing in your issue of Feb. 22, 1960, dated Geneva, in which reference is made to certain business shortcomings at present in France. I feel that certain passages of this article are not quite correct, particularly the reference to an old fashioned telephone system.

As a matter of fact, the French telephone system, whose conversion to automatic switchboards is progressing at least as rapidly in this country as in the U.S. To give an example, I live 45 miles southwest of Paris and since 1935 the dial system has been in operation, which allows me to get a call through instantly, whereas, in order to get my home in Port Deposit, Md., from Baltimore or Washington, it has to go through at least four manual relay operators!

Regarding the lack of taxis, I can assure you that on a rainy day in New York it is at least as difficult to get one as it is here in Paris—and the rates are higher.

The reference to strikes in vital services is definitely out of date, since there have been no such strikes here during the past two years—quite a comparison with the longshoremen's situation in New York which not too infrequently makes it right difficult to handle shipments or dock a vessel.

I am sure you will realize that we are giving you a fair picture of the situation here and I would like to add that in the matter of housing the situation in Switzerland is getting very much tighter than it is in France, judging from the reports received recently from our business visitors from Switzerland.

F. P. Farish
General Manager
American Chamber of Commerce in France
21 Ave. George V., Paris

Prime for *Able*

To the Editor:

Regarding the Navy's *Weapon Able,* listed in M/R's July, 1959, Missile Encyclopedia and March 7, 1960, Astrolog; you list Avco as prime contractor. I wrote Avco for further information. Their reply, forwarded from Cincinnati office of Avco, denies they are prime contractor and that they actually made only a few castings. They did not volunteer the prime contractor's name.

Who is right, you or Avco?

Who is prime contractor?

I am a subscriber (a happy one!)

John D. Neff
Cleveland, Ohio

Avco did do early work on Able, but today the Navy is the only real prime, as it does most of the fabrication work.—Ed.

The Gap: Another View

To the Editor:

Standing as I am on the fringe of the "missile gap," as opposed to having my corporate feet hanging over the edge as is the case of Lanphier, Sprague, Watson and Associates, Uninc., I get the distinct impression that most of the dogs are barking up the wrong tree in the woods that surround the thing thus preventing a clear view of the "gap" by the general public.

The fact that such leaders of industry openly criticize the Administration for its handling of affairs of National Defense is indeed a classic tribute to our inalienable right to freedom of speech and that all-American institution, free enterprise. I am sure that all men who are big enough to be "big men" welcome and solicit good constructive criticism. The question is not, "Do these men with outstanding backgrounds in defense production and financing have the right to criticize?" but rather, "Are their criticisms aimed toward the most objective target?"

The big cry, so far as I have been able to ascertain, is that a tightening of the grip on Uncle Sam's change purse has created the "missile gap." All of the biggest beefers emphasize the fact that a paltry $41-billion defense budget is insufficient to properly meet the situation.

If we are going to shroud our critique with patriotic devotion, as ex-hero Lanphier, et al., are doing, leave us first start, not with a college cheer for bigger and better bucks, but with a look to determine

whether or not J. Q. Public is getting the most he should reasonably expect from his defense dollar.

This is my criticism. It is not directed toward the Administration, Congress, DOD (or even "MISSILES AND ROCKETS" which I think does a fine job if at times ill-advised), but toward the lads who are yelling the loudest, American industry.

It is my guess that a "missile gap" does exist, but I am at once of the firm conviction that the President of the United States is in a far better position to be the judge of this than I—even as Mr. Lanphier should be. Unfortunately, the Treasury is just not large enough to foot the bill for closing the "gap" so long as our approach . . . remains the same.

I, too, am imbued with a modicum of patriotic devotion. I am a staunch advocate of free enterprise. I reserve the right to criticize.

Where the defense of the nation and the taxpayer's dollars are concerned, intra-defense-industry jealous competition has no place. Millions and billions of big "D" dollars have been the victim of industry's claim to a "better mouse trap." The three branches of military service must necessarily be considered as parties to both "defense industry" and "jealous competition," since they are charged with the responsibility of spending the allocated funds and each is fighting fiercely for its respective pet project. This makes them ideal dupes for the wiles of industry's salesmanship.

If ever unification of Defense Department services and industry were desperately needed, now is the hour, to plug the "gap" with a single wad.

Our potential enemy may possess superior implements of defense, but you can bet the $41 billion that it doesn't have a fraction of the variety we do cluttering up the many phases of research, development, production, and obsolesence. Until someone comes up with a formula for bending a genuine, concerted effort toward the development of only those weapons which are second to none, rather that the Canaveral cantaloupes we've been getting, the "missile gap" will continue to serve solely as a hole into which we will pour more and more G.I. dollars.

Ted Wallace
Lawrence, Kan.

Good First Impression

To the Editor:

Last week I had the pleasure of receiving for the first time your excellent magazine.

Permit me to say that I found this magazine very informative and of great scientific value.

For many years, I have been a member of the B.I.S., as well as the Swedish, French and Brazilian rocket societies. I am active in Astronomy and Space program activities.

My communication is intended simply to congratulate you.

C. O. Musser
Exec. Vice President
Director of Research
Scientific Industries, Inc.
Los Angeles

Washington Countdown

IN THE PENTAGON

Poison gas rockets . . .

the Army's new *T-238*—are designed to be fired from 45-tube launchers. The Army wants to buy $32 million worth of the approximately four-inch rockets and launchers in FY '61. The Army is developing the *T-238* to counter Soviet work in the field.

• • •

Undersea launchings . . .

of *Dolphins*—dummy operational *Polarises*—are being conducted by the nuclear-powered submarine George Washington at sea. The *Dolphins* are used to train crews and test launching equipment.

• • •

Total funding for *Skybolt* . . .

in the Air Force's FY 1961 budget requests is $60 million. Some $50 million is for R&D; the rest is mostly for procurement of ground support equipment for the Douglas air-launched ballistic missile.

• • •

Field tests for *Cobra* . . .

are being conducted at Redstone Arsenal. The Army is still evaluating the Daystrom anti-tank missile in competition with the Nord *SS-11*.

• • •

One thousand *Cobras* a month . . .

are scheduled to be turned out by Daystrom at its Military Electronics Division plant to fill Marine Corps orders. This is about 20% of the plant's capacity.

• • •

Cost of BMEWS . . .

for the presently-planned interim phase of the program is expected to be $792.4 million for all three sites. A breakdown shows:

. . . The sites in Alaska and Greenland will cost $711.3 million for construction and equipment.

. . . The site in England will cost $81.1 million for equipment. Construction costs will be met by the British.

• • •

New names for Navy missiles . . .

to bear in mind:

. . . *Super Talos*, the seagoing anti-missile missile, is now the *Long Range Typhoon*.

. . . *Super Tartar*, is now the *Medium Range Typhoon*.

. . . *Able*, the surface-to-underwater rocket, is now Weapon *Alfa*.

The first antimissile missile . . .

for use on the battlefield will be the Convair *Mauler*. The missiles will be mounted on trucks. *Mauler* shipping containers will double as launch tubes.

ON CAPITOL HILL

Defense industry legislation . . .

affecting Pentagon procurement procedures and small business is expected to go nowhere during the current session of Congress. More hearings, yes; floor action, no.

• • •

Steve Leo's recall . . .

by Senator Symington to help with his campaign for President came as no surprise to those close to either man. Leo was the Senator's public relations chief and probably closest advisor when Symington was Secretary of the Air Force. He has been given leave of absence for the campaign by Sverdrup & Parcel, where he is vice president in charge of the Washington office.

AT NASA

Pioneer V's big No. 2 transmitter . . .

will be turned on by May 15. By then the satellite will be some eight million miles from earth and its No. 1 five-watt transmitter probably will be beyond the range of all earth tracking stations except Jodrell Bank. The 150 watt No. 2 transmitter may be turned on as early as April 15 if the smaller transmitter fades sooner than expected.

• • •

Project *Echo*'s launching . . .

may be moved up to next month because of the success of the fourth Shot Put balloon experiment. The passive communications satellite will be 100 feet in diameter.

INTERNATIONAL

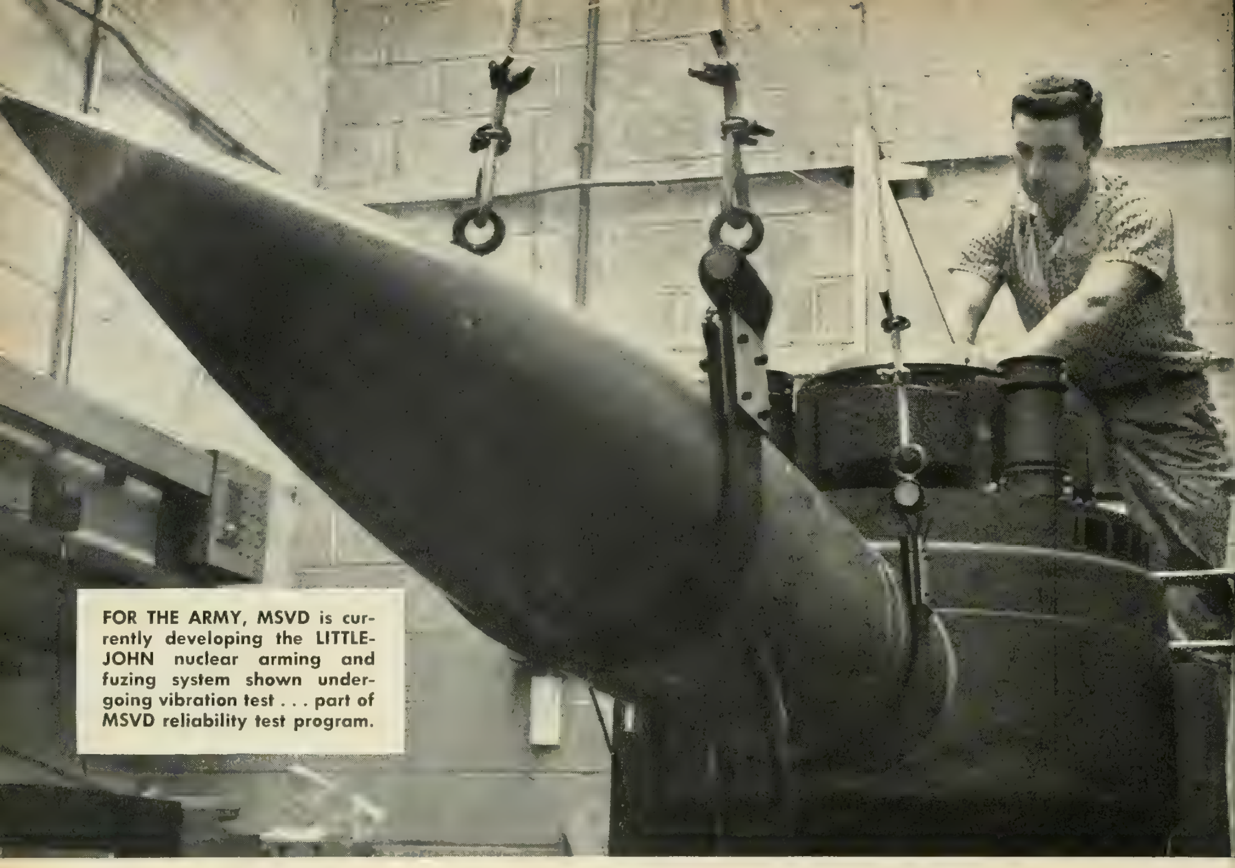
Dead Soviet astronauts?

A Soviet scientist in London recently didn't exactly quiet rumors that the mortality rate of Red astronauts is rising. She categorically denied that any Soviet scientists have been killed in space experiments. But she emphasized the word "scientists."

• • •

French Gen. Ludy Piollet . . .

had some unkind words to say about U.S. ICBM bases after a tour of Warren AFB. He called Warren the "first block of the American Maginot Line." The first *Atlases* are in place at Warren.



FOR THE ARMY, MSVD is currently developing the LITTLE-JOHN nuclear arming and fuzing system shown undergoing vibration test . . . part of MSVD reliability test program.

MISSILE AND SPACE VEHICLE DEPARTMENT | ***...center for missile and space technology research and development at General Electric***

Progress in arming and fuzing

With this nation's growing arsenal of strategic and tactical missiles, increasing emphasis is being placed upon the development of more sophisticated safing, arming and fuzing systems.

General Electric's Missile and Space Vehicle Department was the first industrial contractor selected by U.S. Army Ordnance to furnish safing, arming and fuzing subsystems for nuclear warheads. MSVD has participated in feasibility studies, development, testing, evaluation and production of safing, arming and fuzing systems for ten major U.S. Army and U.S. Air Force surface-launched missiles, including the Army's LITTLE-JOHN, HONEST JOHN, LACROSSE, NIKE-HERCULES, and the Air Force's ATLAS and THOR.

Engineers at MSVD's Missile and Ordnance Engineering Operation who contributed to many of these projects are today working with new safing, arming and fuzing concepts and techniques. These include the development of new fuze designs intended to overcome possible enemy countermeasures, the study of re-entry-stage arming for long-range strategic missiles, and development of direction sensing devices to aid in gaining even more reliable safing measures.

For more information on MSVD's safing, arming and fuzing achievements for the Army and Air Force and other contributions to U.S. space technology progress, write to Section 160-72, General Electric Missile and Space Vehicle Department.

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT

A Department of the Defense Electronics Division

Philadelphia 4, Penna.

Scientists and Engineers interested in career opportunities in Space Technology contact Mr. T. H. Sebring, MSVD.

Circle No. 5 on Subscriber Service Card.

Industry Countdown

MANUFACTURING

AF interest is perking up . . .

in PERT (Program Evaluation Review Technique) developed by the Navy's Special Projects Office to manage *Polaris* weapon system development. ARDC's Lt. Gen. Bernard Schriever is urging his commands to apply the PERT system to new development programs. PERT's big advantage, already recognized by industry, is that it offers a means of making time-saving decisions in one-time-only R&D. Aerospace Industries Association also is investigating the broader applications of PERT to take into consideration costs and resources. AIA is working with ARDC and AMC to include standard progress reporting and objectives in initial phases of R&D programs.

• • •

Breakdown of 1961 . . .

Defense budget being circulated by the marketing group of one large company shows for missiles: Army $410 million; Navy $400 million; AF $2.7 Billion. This forecast puts missile expenditures in 1970 at: Army $600 million; Navy $800 million and AF $4.4 billion.

• • •

Biggest current gripe . . .

of companies in the missile component field is directed against what they feel is growing trend throughout DOD to increase in-house capability. Many believe that at the same time, because of slight reward for company-funded R&D, reliability is going by the boards.

• • •

Anti-union fight . . .

is being waged by the National Society of Professional Engineers. NSPE objects not only to unionization of its own members, but is campaigning against collective bargaining for engineering technicians, with whom they work.

• • •

There's speculation . . .

the Navy will open a Fleet Ballistic Submarine depot at San Francisco, like the one recently commissioned at Charleston, S.C. But it will be a long time before the Navy takes the step, insiders feel, particularly if there is no immediate large increase in the number of *Polaris* submarines.

PROPULSION

Big sell of continuous mix . . .

process is being conducted by Thiokol, one of the main bidders on the AF's multi-meg solid booster Project 3059. Thiokol, which favors on-site loading for large solid-fueled rockets, demonstrated its continuous mixer March 31 at Marshall, Tex., to about 60 representatives from DOD, Army, STL and two dozen prime contractors.

• • •

It's still a three-horse . . .

race for the NASA contract to build the 200K hydrogen-oxygen engine to power *Saturn's* middle stages. Aerojet-General, Pratt & Whitney and Rocketdyne are the top contenders, with Aerojet rated in the post position. Decision is expected in about three weeks.

• • •

Now flying with production . . .

model General Electric J85-7 turbojet engines is the AF's GAM-72 *Green Quail* decoy missile. The bird, primed by McDonnell, is reported to have exceeded maximum altitude obtained with development engines on recent launch from a B-52.

ASTRIONICS

A dozen organizations . . .

have submitted informal plans to NASA to use their own equipment to bounce signals off the Project *Echo* sphere. They include the Army Signal Corps at Fort Monmouth, N.J.; Alpha Corp. of Collins Radio, Dallas, Tex.; AVCO/Crosley; General Electric; Haverford College; ITT Labs; RADC/Philco, Rome, N.Y.; Development Engineering Corp.; Stanford Research Institute, and Jodrell Bank.

• • •

From Motorola's Dr. Dan Noble . . .

". . . solid state electronics is the next dominant force which . . . will lead, in the next 30-40 years, the new cycle of electronic industry expansion." Noble contends "solid statesmanship" will breach the barrier of equipment complexity and achieve complex-system reliability.

WE HEAR THAT

DOD has withdrawn . . .

participation in the Air & Space Exposition planned for Los Angeles April 14. Major industry support also is lacking, but promoter Charles McLaughlin still plans to hold the show . . . Stanford Research Institute is investigating a new type cermet with randomly oriented grains which are formed by depositing alternating thin layers of metal and ceramic and crushing them. New material is said to have improved ductility . . .

Bomarc Proposal Irks Canada

Parliamentary opposition charges government was sold out by U.S.; defense minister reasserts faith in missile

by James Baar

The Air Force's proposed slash of the *Bomarc-B* program (see M/R, April 4) is causing a major uproar in U.S.-Canadian relations.

The embarrassing questions which the Canadians are asking both publicly in their Parliament and privately in U.S.-Canadian talks are:

• Why should Canada buy two squadrons of Boeing *Bomarc B's* if the U.S. Air Force regards these air-breathing missiles as nearly obsolete?

• Why wasn't Canada informed of the Air Force proposal in advance of its release to the public?

The Canadians are building two *Bomarc-B* bases. One at North Bay, Ontario, is already under construction. The other will be built at Mont Laurier, Quebec.

One squadron of 400-mile-range *Bomarc-B's* is scheduled to be deployed at each base. Each squadron is comprised of 28 missiles.

News of the Air Force proposal—approved last week by the White House—caused an immediate political free for all in the Canadian Parliament.

• **Sell-out?**—Opposition party members charged that the Administration had, in effect, allowed itself to be sold out on the *Bomarc* program by the United States.

Liberal Party Leader Lester Pearson, whose own party had been sharply criticized in the past for its defense policies, said he was stunned by the news that the United States planned to abandon the *Bomarc* program. Other opposition members charged that Defense Minister George Pearkes had been kept in ignorance of what was going on in Washington.

Pearkes denied it. He said Washington had informed him of the Air Force proposal. However, he did not have time to tell Parliament about it before the news broke in the press.

Pearkes said he had "not lost faith in *Bomarc*." He said he would not "give it up on hearsay that it may not be successful."

Pearson said he was surprised that Pearkes' "confidence remained unimpaired." He charged that the $40.4 million left in the Air Force budget for FY '61 was for "funeral expenses."

One opposition member—Hagen Argue—called *Bomarc* "a dead duck." Other opposition members charged that Canada was wasting $125 million on the program.

• **Still in picture**—Pearkes insisted that *Bomarc* would remain an essential part of the North American defense on both sides of the U.S.-Canadian border. He also said the Canadian bases would cost only $15 million. However, this figure apparently did not include the cost of the missiles—about $50 million.

In Washington, Air Force officials pointed out that the United States still would have three *Bomarc-B* bases despite the cuts, as well as five 200-mile-range *Bomarc-A* bases.

Moreover, they continued to insist that the proposed cuts were not brought on by any doubts resulting from repeated failures in the *Bomarc* development program. They said the cuts reflected only the changing nature of the Soviet threat from aircraft to ICBMs.

The Air Force wants to take $136 million of the money saved from *Bomarc* cuts for enlarging *Atlas* squadrons. The last six of 13 planned *Atlas* squadrons would be enlarged from nine to 12 launchers. This would increase the total number of *Atlas* launchers planned from 114 to 132.

• **Angry press**—The Canadians apparently were not assuaged.

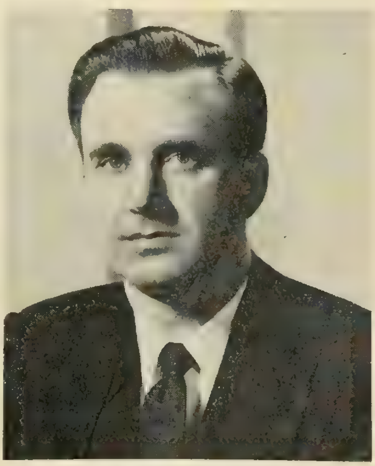
The Toronto Globe & Mail suggested in an editorial that Canada had been poorly treated by the United States. The Montreal Gazette said: "The issue of the *Bomarc B* has produced almost complete confusion among the Canadian people. . . . The practice of not taking the people fully and frankly into its confidence has left the government in the position where few Canadians understand what it is trying to do and why it is trying to do it."

The Globe put it all more bluntly in a cartoon. It depicted Pearkes tied to a *Bomarc* with chains. Two U.S. Air Force officers stood beside it lighting the fuse.

Horner Will Resign from NASA

Richard E. Horner, Assistant Administrator of NASA and the man who many Washington observers thought might replace T. Keith Glennan as Administrator at the end of the year, will leave NASA for a position in private industry this summer.

Reliable sources have informed M/R that NASA will announce the Horner resignation in the near future.



Richard E. Horner
. . . attracted to industry?

Principal reasons for the resignation are thought to be the attractions of pay and security that employment in private industry offers. Horner, 42, has spent 22 years in government, both in the military and as a civilian. He has two children, one of college and one of high school age.

Horner brought to the NASA position created for him the talents of an administrator combined with technical knowledge. He holds a B.S. from the University of Minnesota in Aeronautical Engineering, and a Masters degree from Princeton University.

Commissioned a second lieutenant in the Army Air Corps in 1940, Horner served as a pilot with tactical units during World War II, winning the Silver Star, the Air Medal with four clusters, and the Presidential Unit Citation. Released from active duty for medical reasons as a Col. USAF, in 1949, Horner became an aeronautical development engineer at the AF Flight Test Center at Edwards AFB.

In 1952, Horner became technical director of the test center; in 1955, deputy director for requirements to the Assistant Secretary of the Air Force for R&D; 1956, Acting Assistant Secretary of the Air Force for R&D; and 1957, Assistant Secretary of the Air Force for R&D.

First Launching of *Samos* Draws Near at Point Arguello

First Atlas-type gantry is almost ready; target date for completion of range instrumentation is June 1

by Richard Van Osten

POINT ARGUELLO, CALIF.—Activity aimed at not-too-distant-future firings of the Air Force's polar-orbiting *Samos* reconnaissance satellite is accelerating at the Pacific Missile Range's Naval Missile Facility here.

The initial *Atlas*-type gantry of the two-position launch complex No. 1 is virtually complete. Fuel and LOX facilities have been installed. Blockhouse instrumentation is well along.

The *Samos* gantry is 135 ft. high—slightly taller than the similar operational *Atlas* version. Total vehicle height will be a little larger than the *Atlas* due to second-stage hardware, but the principal reason for the extra gantry height is to provide adequate work platforms for the upper stage. The vehicle will consist of a modified *Atlas* and the *Agena*.

The basic booster assembly will be moved into position with an *Atlas* transporter erector, but the fixed ground unit for the erection fulcrum is not quite identical to that in the operational *Atlas* system.

Principal positioning of the *Atlas* booster is accomplished by large pins in the erection unit which fit into each side of the booster. Ground location pins used in operational *Atlas* systems are replaced by tie-down rods on either side of the erection unit's aft section.

• **Other changes**—Blockhouse instrumentation is based upon operational *Atlas* control panels as far as the actual *Samos* launch is concerned. Principal visual differences are the addition of second-stage data on the wall-mounted system status panel and the substitution of *Agena* roll control data for other operational controls on what would normally be the launch officer's control panel. Instrumentation includes special display panels applicable to *Samos* and other satellite vehicles.

The Navy describes Point Arguello as a "sanitized" installation. There are no plans to house personnel on the facility other than a small detachment of Marine security guards. All other personnel, military and civilian, are housed or otherwise supported by USAF facilities at nearby Vandenberg, AFB.

Dr. Von Braun Leaves M/R at NASA's Request

Missiles and Rockets regrets the resignation of Dr. Wernher von Braun from its Editorial Advisory Board pursuant to the letter below. Dr. von Braun has been a member since the magazine's first publication in 1956. The letter:

As you know, the Development Operations Division of the Army Ballistic Missile Agency, of which I am Director, is in the process of being transferred to the National Aeronautics and Space Administration. NASA headquarters in Washington has advised me to resign from the Advisory Board of MISSILES AND ROCKETS Magazine because they feel that the commercial aspects of the publication could conflict with some aspects of my new position.

Pursuant to their request, I hereby submit my resignation from the Editorial Advisory Board of MISSILES AND ROCKETS Magazine, effective this date.

Please know that my association with the Board members and editorial staff of MISSILES AND ROCKETS has been a most pleasant one and that I wish you every success in the future.

With kindest regards, I am

Sincerely yours,

Wernher von Braun

Director

Development Operations Division

National Aeronautics and Space Administration

Point Arguello range instrumentation is almost ready for full operational status in line with PMR's support mission. Target date for completion is June 1. First *Samos* launch should take place soon after that.

• **Other range services**—But not all of Point Arguello is concerned with exotic satellite projects. The Marine Corps, for example, conducts regularly scheduled *Terrier* training at the site. For this, NMFPA provides range scheduling liaison, frequency interference control (FIC), target drone service and recovery, range clearance, ground safety, radar tracking and base support to encamped personnel. Both *Terrier* and *Hawk* operations are scheduled for an indefinite period.

For *Thor* and *Atlas* shots from Vandenberg, NMFPA provides range scheduling, FIC, range clearance radar and optical tracking, impact prediction, impact location, data processing and reduction (NMFPA has its own IBM 709 computer leased for $40,000 per month), and telemetry backup. These services will continue into 1960 for *Thor* and into 1964 for *Atlas*.

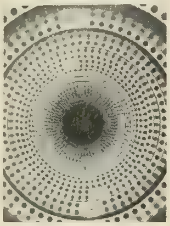
Services for *Discoverer* and *Samos* consist of telemetry, radar and optical booster fallout, range clearance, range safety, photo facilities, range scheduling tracking, FIC, impact prediction for and data reduction. In addition, meteorology and ground safety are provided for *Samos* only. *Discoverer* operations may continue into 1964, according to PMR's schedule. *Samos* services are slated to begin in 1960 for an indefinite period.

Much the same services are provided for two other projects, *Sunflare* solar disturbance studies, and Sandia/AEC's *HAS* (high-altitude sampler) Project *Tumbleweed* operations, both of which are launched from NMFPA, and are scheduled to continue for an indefinite period.

Still another current support program is for the Office of Naval Research's Project *Tepee* aircraft and missile detection system. This also is slated to begin this year and continue indefinitely.

• **Crowded schedule**—Firm future programs for which NMFPA will provide services include *Titan* ICBM launches from Vandenberg, *Midas* (like *Samos*, scheduled for launch from NMFPA) and NASA's *Nerve* (Nuclear Emulsion Recoverable Vehicle). Some tracking facilities are now under construction for PMR's portion of Project *Mercury*. With the exception of *Mercury* and *Titan*, all the above operations are scheduled for NMFPA support beginning this year and continuing indefinitely. *Titan* support, however, is scheduled only to 1964.

Next Week—Saturn Fabrication



The largest, most intricate fabrication job ever attempted in the missile/space business is Saturn. In next week's M/R, H. H. Maus, Chief of the Fabrication and Assembly Engineering Laboratory of the George C. Marshall Space Flight Center at Huntsville, relates in an exclusive by-lined article some of the problems encountered.

Maus has also contributed a picture story and captions detailing the various steps in Saturn's fabrication.

—news briefs

REDS 5 YEARS BEHIND—Rear Adm. William F. Raborn, commander of the Navy's Special Projects Office, asserts the *Polaris* Fleet Ballistic Missile weapon system is at least five years ahead of any comparable submarine-launched ballistic missile system in Russia. He said the invulnerability of *Polaris* would be enhanced by a projected increase in the missile's range from 1500 to 2500 miles, giving the submarines more room to maneuver.

EXCESS PROFITS CHARGED—Telecomputing Corp., Van Nuys, Calif., was charged by the General Accounting Office with making a 29% profit on subcontracts for $17.5 million worth of *Nike-Ajax* gyros. The agency said Western Electric accepted Telecomputing's prices without obtaining information on its cost experience "or other evidence of reasonableness of the proposed prices."

MILD 'INFLUENCE' BILL—The House Armed Services reported to Congress a mild version of a bill to discourage defense contractors from hiring former military officers for selling jobs within two years after leaving the service. The committee eliminated criminal penalties in the original Hébert Subcommittee measure and instead provided that violators would lose their retirement pay.

MINUTEMAN SILO POP-UP—The Air Force popped a seventh *Minuteman* ICBM from an Edwards AFB silo April 5. The tethered missile carried simulated flight hardware.

ARMS TALKS SNAG—Geneva disarmament talks struck a blind alley when Russia refused to join in an agreement to ban the launching of satellites carrying nuclear bombs unless the United States agreed at the same time to liquidate its foreign military bases. Soviet delegates claimed the U.S. was injecting space control into the talks as a scheme to catch up in this area.

IKE OKAYS FUND SHIFT—DOD plans for beefing up the *Atlas* and *Polaris* missile programs have been approved by President Eisenhower. The new funding emphasis, designed to be made within the $41-billion defense budget ceiling, also calls for cutbacks in *Bomarc* air defense squadrons and in hardening the SAGE system.

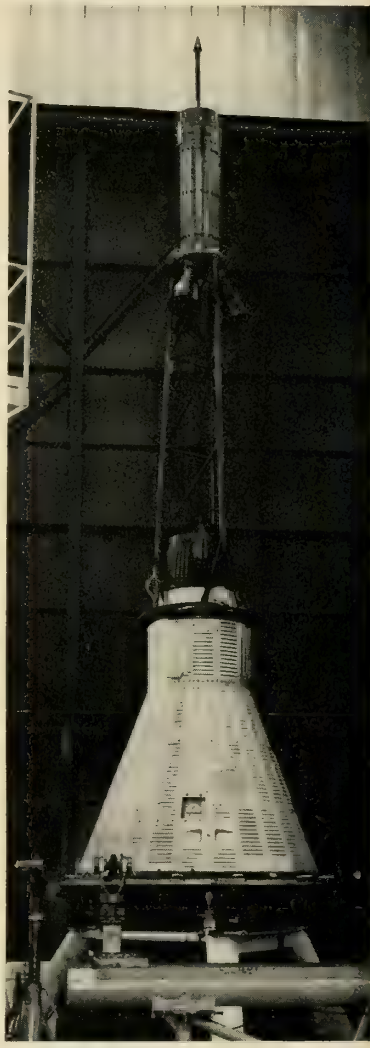
HIGHER NET SEEN—Wall Street sources report Avco Corp. sales and earnings are expected to rise sharply in the current fiscal year which ends for the company on November 30. Sales are expected to be more than 10% greater than the $306 million recorded in 1959.

CUSHY RR RIDERS—*Polaris* missiles will be transported by railroad under a contract signed by the Navy and the New York Central. The Birds will be in containers and ride on large air-filled rubberized pillows.

DOUGLAS CUTS PAY—The pay of 13,500 salaried workers is being cut by the Douglas Aircraft Co. as of April 11. There also will be a 60-day moratorium on merit pay increases. Union officials interpreted the cuts as a move to discourage wage demands in current contract negotiations, but the company said they were one of several economies intended to put the company in a stronger competitive position.

NO CUTBACKS AT PATRICK—Rumors to the contrary, no cutbacks or layoffs are contemplated at the Air Force Missile Test Center, according to Maj. Gen. Donald N. Yates, center commander. The workload at Cape Canaveral actually will increase over the next few months, Yates declared, from 15% to 50% in different areas. The projected shift of some areas of responsibility from RCA to Pan American apparently gave rise to the cutback rumors.

Mercury Capsule



FIRST OF the Project *Mercury* space capsules instrumented for escape system tests have been delivered to National Aeronautics and Space Administration by McDonnell Aircraft for testing at Wallops Island, Va. Delivery of the first capsules was accomplished less than 14 months after contract was signed.

most comprehensive yet . . .

ARS Meeting to Include 29 Sessions

The American Rocket Society Semiannual Meeting and Astronautical Exposition at Los Angeles May 9-12 promises to be the most ambitious and comprehensive ever held. All phases of the missile/space industry will be covered in 29 technical sessions ranging from education to underwater propulsion. One symposium will be devoted to the marketing aspects of the industry.

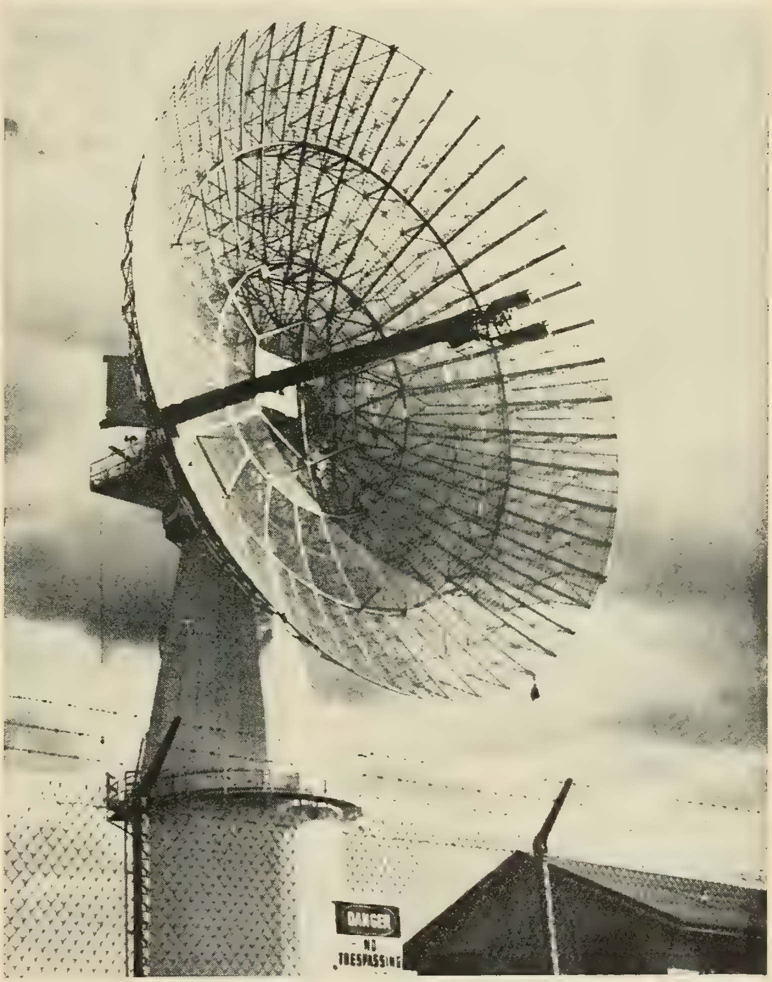
Field trips to Edwards AFB, Rocketdyne, and North American will be available to a limited number of cleared members.

Luncheon speakers include ARS president Howard Seifert; Bruce Old, vice president of Arthur D. Little; and Maj. Gen. Donald Ostrander, NASA.

Technical sessions and chairmen—

- **Hypersonics**—Alfred J. Eggers, NASA, Ames Research Center.
- **Missiles and Space Vehicles**—Richard de Lauer, Space Technology Laboratories.
- **Lunar Exploration**—Herbert Friedman, Naval Research Laboratory.
- **Human Factors Considerations in Maintainability and Trouble.**
- **Shooting**—Stan Deutsch, Douglas Aircraft.
- **Human Factors**—Laurel van der Wal, STL.
- **Ion and Plasma Propulsion**—Rolf Buhler, Giannini Plasmadyne.
- **Hypersonic**—George Solomon, STL.
- **Propellants and Combustion**—Melvin Gerstein, NASA, Lewis Research Center.
- **Latest Events in Space Flight**—Homer Newell, Jr., NASA.
- **Magnetohydrodynamics** — Joseph Neuringer, Republic Aviation.
- **Instrumentation for Combustion Stability Research**—John Witherspoon, Rocketdyne.
- **Hypersonics**—Henry T. Nagamatsu, GE Research Laboratory.
- **New Uses for Liquid Rocket Engines**—Charles H. King, Jr., Pratt & Whitney.
- **Support Equipment for Mobile and Hard Launchers** (secret)—Robert Kendall, Arthur D. Little, Inc.
- **Electrostatic Propulsion**—Nathan W. Snyder, ARPA (Institute for Defense Analyses).
- **Solid Rockets**—H. L. Thackwell, Jr., Grand Central Rocket.
- **Capabilities of Liquid and Solid Rocket Propellant Engines** (secret)—Y. C. Lee, Aerojet-General.
- **Guidance and Navigation**—Donald P. LeGalley, STL.
- **Power Systems**—Eugene B. Zwick, Sundstrand Turbo Div.
- **Space Observation Systems**—Sidney Sternberg, RCA.
- **Underwater Propulsion**—Charles Sandler, Navy Bureau of Weapons.
- **Space Law and Sociology**—Andrew G. Haley, ARS.
- **Space Observation System.**
- **Nuclear Propulsion Instrumentation and Controls**—A. R. Crocker, GE.
- **Nuclear Propulsion**—Raemer Schreiber, Los Alamos Scientific Lab.
- **Astrodynamics**—Louis G. Walters, Aeronutronic.
- **Astrodynamics**—R. M. L. Baker, Jr., AF Ballistic Missile Division.
- **Education**—F. C. Lindvall, Cal Tech.

Big Antenna Goes Up for ARGMA



AN 84-FOOT ANTENNA—largest of its type in the Southeast, and one of the largest in the U.S.—is being installed atop Madkin Mountain for the Army Rocket and Guided Missile Agency. Builder of the antenna is the D. S. Kennedy Co. of Cohasset, Mass.

Part of a system under development by the Ordnance Missile Laboratories Division of ARGMA, the antenna will be used initially in tracking artificial satellites and for radio propagation research. Future plans call for the addition of radar equipment to support the *Zeus* antimissile missile system.

Marquardt Hyperjet Engine Tests Boost Boron Promise

These exclusive first photos of Marquardt Corp.'s hyperjet development engines show the large 36-in. rocket engine used to test high-energy boron fuels at Edwards Air Force Base and the much smaller engine used in flight tests at the Navy's Pacific Missile Range at Point Mugu.

The large rocket engine has been operated at a thrust level of some 100,000 lbs. in facilities at the Air Force Directorate of Rocket Propulsion and Missiles at Edwards.

These tests were part of a program sponsored by Wright Air Development Division to develop a combined rocket-ramjet (hyperjet) engine (M/R, Mar. 21, p. 10.) The company reports that, while the tests just completed were limited to 100,000 lbs. static thrust on the large engine, this same size hyperjet has a design capability with slight modification of 250,000-lbs.-thrust.

The ramjet portion of the engine tested at Edwards has been flown three times on the Lockheed *X-7* at speeds and altitude of over Mach 4 and 90,000 ft. These flights are indicated by the *X-7*'s painted on the side of the engine.

"These large-scale tests proved that it is practical to combine optimum rocket and ramjet performance in a single large powerplant," the company says.

• **Record performance**—Company president Roy E. Marquardt says performance levels produced by the boron fuels are higher than those obtained from other storable liquids and from current nonstorable liquids used in today's missiles.

Tests with the large engine resulted in the highest performance ever attained with storable liquid propellants on a large scale. A storable oxidizer was used with the boron fuel.

"The high-energy fuels have the added advantage of being storable on board the missile so that it can be fired instantly," Marquardt said. "The series of tests we have just concluded on our rocket engine demonstrated that performance of boron fuels is superior to that available from solid propellant rockets."

From the photo, length of the large rocket engine appears to be somewhat more than 21 feet. Diameter of the nozzle at the outlet is about 42 in., at the throat about 24 in. Inlet diameter appears to be about 28 in. Piping in the center of the test engine is for fuel.

The smaller engine equipped with telemetering antenna is on a considerably reduced scale. It was flight-tested at Pt. Mugu as long ago as December, 1958. The test vehicle consisted of two *Nike* boosters. The program was conducted jointly by Marquardt and what is now its Cooper Development Division.

Smaller Hyperjet Has Been Flown

Marquardt's 36-in. Hyperjet Engine

Hughes' Missile/Space Sales to Rise in 1960

Hughes Aircraft sales in the space and missile field this year will total $30 million or more, up from $4.5 million last year, according to general manager L. A. Hyland.

"We have always known that eventually there would be a substantial reduction in that part of our business associated with manned aircraft," Hyland said. "We have for years planned against that time. It just came a little sooner than anyone could have foreseen."

Cutbacks in manned aircraft will mean that for the first time in recent years, sales volume during 1960 will be lower for the one year than that of the year before, the Hughes executive told the company's Culver City management club.

Hyland noted that 1958 sales of Hughes in the space and missile field (other than the *Falcon*) totaled $175,000. He cited the $30-million figure for 1960 as an indication of the company's rapid diversification into the missile and space fields.

"We are attacking market problems with our total strength," Hyland said, "and our first objective is to bring new contracts to those sections of the company that have experienced cancellations."

Army Working on Moon Map Better Than Some of Earth

The Army Map Service announces plans to produce a map of the moon that will give "the first man to set foot on the moon better maps than are in existence now for many of the remote parts of the earth."

The Office of Chief of Army Engineers, Maj. Gen. E. C. Itschner, said first steps are under way to produce a 1:5,000,000 scale lunar map. Photographs have been acquired from observatories across the country. From these, the mapmakers expect to obtain enough photographs with stereoscopic effect and image resolution to provide coverage of the area to be mapped.

Map Service experts predict even greater accuracy in future maps, as new equipment and techniques are developed. They say a scale of 1:250,000 may be possible when photographs are obtained from aerial balloons.

Minneapolis-Honeywell Sales Set Record

While M-H had a record breaking year in sales, its Philadelphia industrial operation's earnings were cut by a 10-week strike in the first half of the year. Military sales did recover from subnormal 1958 levels.

RP/T Opens Big Arizona Solid Plant

LOW-COST *Phoenix* rocket-powered space probe, which will seek new data on the upper atmosphere, was built by RT/P.

SOLID FACILITY near Mesa includes (at left) building for preparational and finishing operations, (at right) heavily barricaded structure for hazardous mixing, curing and loading, and (background) 7000-square-foot engineering building.

MESA, ARIZ.—Facilities for production of 100,000 pounds of solid rocket propellant per month have been put into operation here by Rocket Power/Talco, a division of the Gabriel Company of Cleveland. The new facilities, built from the start as the most modern solid rocket production area possible, can turn out solid rockets of 5000 pounds weight.

RP/T, headed by Charles E. Bartley, is currently producing polysulfide, polybutadiene, and composite propellants, and is conducting research on fluorocarbons ("most promising"), boron, acrylic acid, and light-metal propellants. Company research is also being done on ion and colloidal propulsion devices at its Pasadena research facility.

The company foresees $5- to-$10-million in sales for the division during calendar 1960.

With the opening of its latest facility, RP/T brings its production and research locations to three: Falcon Field (just outside Mesa), the engineering center two miles north of Falcon Field, and the Pasadena Research facility.

• **Elaborate operations**—Administration offices, machine shops, test laboratories and warehouses are located at Falcon Feld. The 68,000-square-foot facility consists of renovated and expanded buildings at the site of the Mesa municipal airport.

Engineering offices for the division are located two miles north of Falcon field, in a 7000-square foot building.

Rocket Production Facilities are adjacent to the engineering building in a 50,000-square foot pair of buildings, each 500 feet long and separated by a service area. Constructed of reinforced concrete, these two structures feature separate barricaded areas for each operation in the rocket motor production process.

Preparational and finishing operations, including inspection, assembly, quality control and development laboratory work, are located in one building. The second building accommodates mixing, curing, loading and static firing operations. Separate bays of reinforced concrete are used at the propellant plant for static firings, while the Falcon Field area has a 360-foot track for ballistic tests.

The division presently has 300 employes, and expects this number to increase to about 500 within the next two years.

Automation is a principal feature of the production area, providing both safety and efficiency.

• **Products varied**—One of the newly-designed products being made by RP/T is the *Phoenix*, a low-cost probe capable of taking a twelve-pound payload to over one million feet altitude. The *Phoenix* was designed, developed and test fired within 100 days, under an Air Force research program on behalf of the University of Maryland. Payload is reportedly being designed by Dr. S. Fred Singer.

Other products developed by RP/T include devices for manned aircraft escape systems, including canopy actuators, leg-arm positioners and man-seat separators. The company's products in this line are now standard equipment on such aircraft as the *X-15*, B-58, B-47, B-70, A3J, F-104, F-106 and F8U. In addition, RP/T produces components for the *Hound Dog* and *Corvus,* as well as rocket motors for sleds, drones and aircraft. Infrared emitters, gas generators and actuating cartridges are also produced.

Key personnel include: Charles E. Bartley, President, founder and former president of Grand Central Rocket Co.; Frank A. Marion, Executive Vice President; Sidney E. Danyow, Vice President for Ballistic Operations; John K. Elder, Vice President for Chemical Operations; Milton Farber, Vice President for Research; A. Lincoln Pittinger, Vice President for Marketing; John W. Sheehan, Vice President, Administration; and David E. Shonerd, Vice President, Engineering.

WEST COAST Electronics Center of Radio Corporation of America was dedicated at Van Nuys, Calif., last week. Dedicated to "strength through electronics," the new RCA facility has a staff of more than 400 space electronics engineers working on such projects as this data readout system being developed for BMEWS.

GE REORGANIZES: General Electric's Electronic, Atomic and Defense Systems group has been renamed the Electronic and Flight Systems group. Headed by C. W. LaPierre, VP and group executive, it includes Defense Electronics division, Syracuse; Electronic Components division, Owensboro, Ky.; and Flight Propulsion division and Aircraft Nuclear Propulsion department, both of Cincinnati. The Industrial Electronics division has been transferred to the Industrial group under VP Arthur F. Vinson. The Communications Product department moves from the Industrial Electronics division to Defense Electronics division.

C-E-I-R: PURCHASES TSI: C-E-I-R, Inc. of Arlington, Va. is purchasing Telecomputing Services, Inc. for $940,000. The California data-processing firm entered 1960 with a backlog of $2,850,000.

VARIAN ACQUIRES SEMICON: Varian Associates is entering final negotiations to acquire 100% ownership of stock in Semicon Associates, Inc., an electronics firm specializing in dispenser cathodes.

DATAGRAPHIC GROWS: Microfilm Co. of California has been acquired by DataGraphic Systems, Inc., jointly owned by Douglas Aircraft and General Aniline & Film Corp. DataGraphic VP Russell S. Ellsworth will be president of Microfilm.

LING-ALTEC FORMS COMPANY: Ling-Altec Electronics, Inc. has formed a new company, Ling-Altec Service, to service and install vibration and high-intensity sound equipment produced by the firm.

STAUFFER BUILDING: Groundbreaking ceremonies were recently held by the Stauffer Chemical Co. for a new $1.6-million research center at Richmond, Calif.

LEAR GETS NEW OFFICES: Corporate executive offices will be housed in a new building planned by Lear, Inc., in Santa Monica.

AMERICAN TIME MOVES: American Time Products, Inc. has moved to new headquarters in Woodside, L.I., N.Y.

ELECTRONIC COUNTERS RELOCATES: Electronic Counters, Inc. announces the occupancy of a new manufacturing plant in Syosset, L.I., N.Y.

BUDD CO. BUYS TESTING FIRM: The Budd Co. has acquired the assets of Metrol, Inc., manufacturers of electromagnetic nondestructive testing equipment. The new California department will operate as part of The Budd Co.'s Instruments Division.

LOCKHEED ELEC. TO MOVE: Lockheed Electronics has purchased a 212-acre site near Princeton University to make future headquarters. Plans call for expanding the Military Systems-Stavid Division and accommodating several new operating divisions now being formed within the organization.

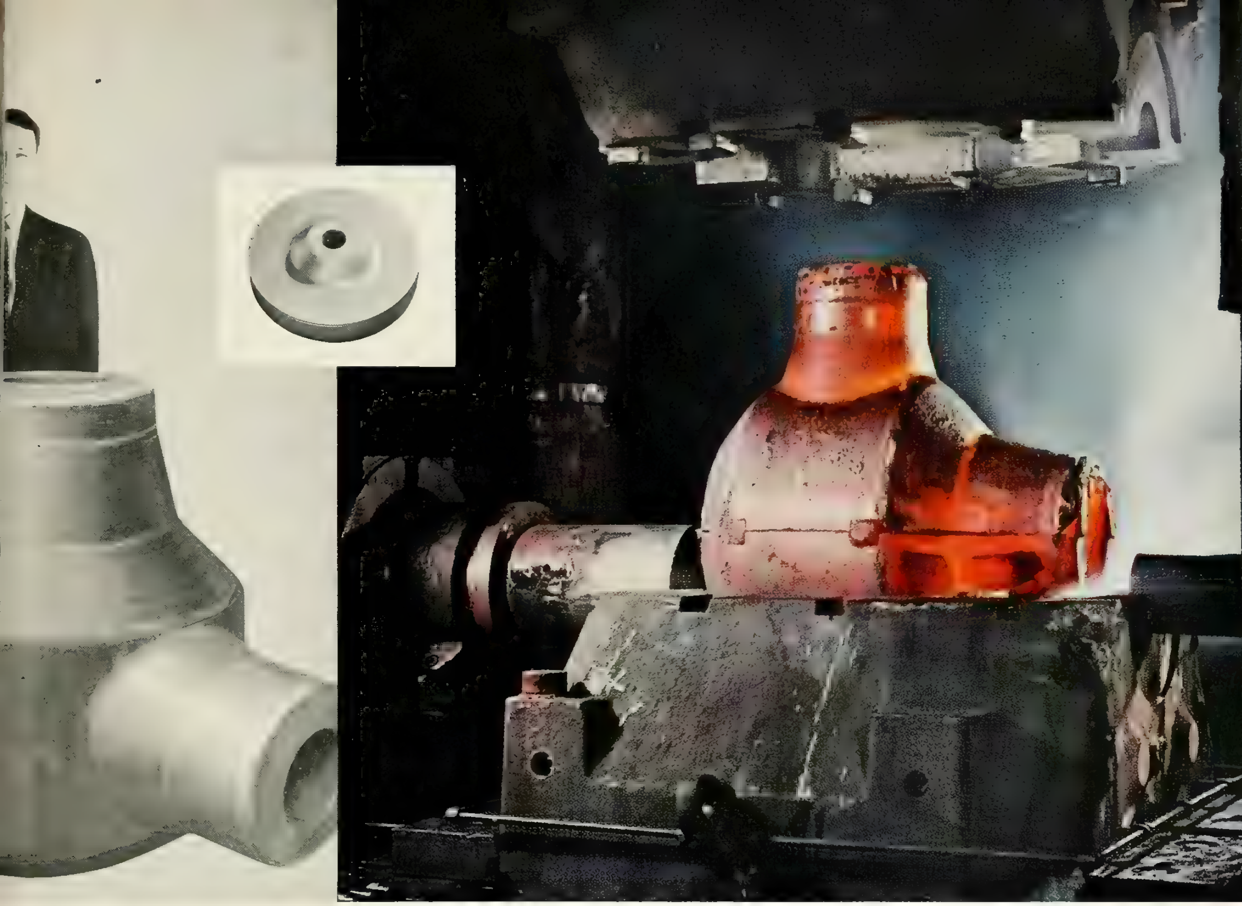
LINDE TO BUILD PLANT: North Haven, Conn. has been chosen as the site of a new Flame-Plating process facility by Linde Co., Div. of Union Carbide. Ground will be broken in May and completion is expected in December.

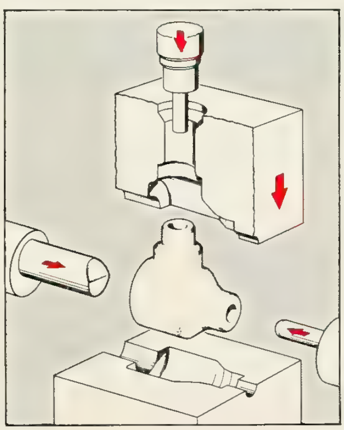
UNITED-CONTROL ESTABLISHES IN L.A.—An engineering services and liaison office will be established in Los Angeles by United Control Corp., of Seattle.

FLEXONICS WILL RE-LOCATE: Flexonics Corp. will build new headquarters on a 50-acre tract in Bartlett, Ill., near Elgin. General offices, R&D and manufacturing operations will be located there.

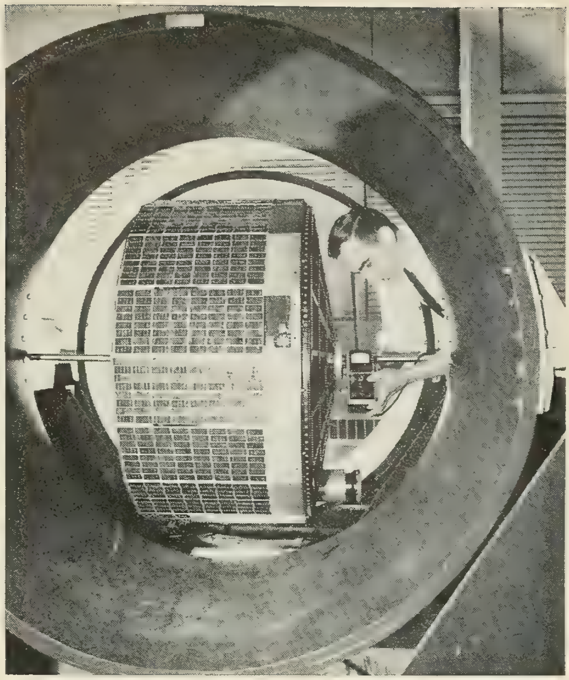
FLORIDA'S FIRST 'AIR' PLANT: Ground-breaking recently was held by the Air Reduction Sales Co., division of Air Reduction Co., Inc., in Tampa, Fla., for the state's first commercial liquid air separation plant.

(continued on page 48)





COMPLETE SATELLITE is positioned for tests of solar cell power supply at RCA Astro-Electric Products Div., Princeton, N.J., where *Tiros* and its ground system were built for NASA under Army direction, by Asst. Project Mgr. A. Schnapf.



DRUM-SHAPED *Tiros* is placed on its side in a special AEP magnetic drag test device to measure effect on satellite of earth's magnetic field. Engineer Robert Wilkes observes effect as satellite rotates on its axis between large magnetic coils.

Tiros Presages Long-range Forecasts

Highly successful first launching also proves feasibility of military reconnaissance satellite

by Paul Means

Mark Twain's observation that "everybody talks about the weather but nobody does anything about it" lost a little of its weight on April Fool's day with the launching of *Tiros I*, the 270-pound camera-carrying weather satellite.

The satellite—the first of a series to give the Weather Bureau a satellite's eyeview of the earth's cloud formation—doesn't actually do anything about the weather, but eventually it will enable meteorologists to anticipate storms many days in advance.

The satellite also demonstrated the feasibility of a reconnaissance satellite which could seek out enemy missile bases.

The payload, which looks like a giant pillbox, is encrusted with 9200 solar cells developed by Hoffman Electronics Corp., and contains two miniature television cameras, video tape recorders, transmitters, rechargeable battery power supplies, and an array of control and communications equipment.

Orbiting in a 48-degree angle of inclination from the equator, the wide-angle camera, which has a resolution of about a mile and a half, will take a strip of overlapping pictures of the earth each 135 miles long and about 800 miles wide.

The smaller camera, with a resolution of about 1500 feet, will take pictures of about 100 miles in width.

• **Northern exposure**—Both cameras, developed by the Astro-Electronic Products Division of the Radio Corporation of America, have been programed so they will operate only while over the Northern Hemisphere, and in the sunlit area. During the lifetime of the satellite (approximately three months and 1300 orbits), its cameras will have taken pictures of most of the Northern Hemisphere.

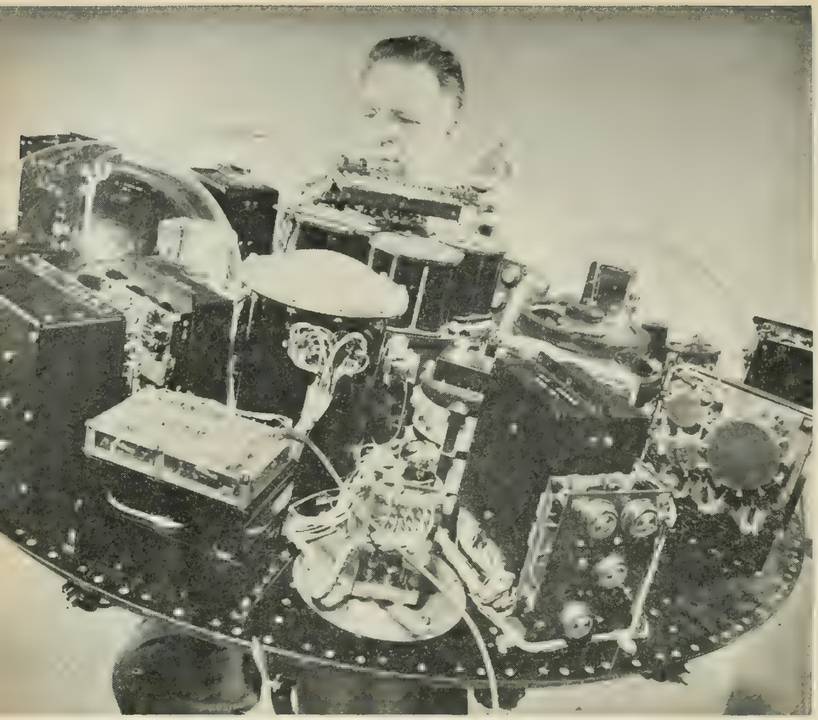
Both of the cameras use a one-half Vidicon tube designed for satellite use. A focal plane shutter permits still pictures to be stored on the tube screen, and an electron beam converts the stored picture into an electronic signal which is transmitted to ground receivers.

The wide-angle camera has a f/1.5 lens speed; the narrow-angle camera f/1.8. Shutter speed for both cameras is 1.5 milliseconds, lines per frame is 500, frames per second one-half, and the video bandwidth is 62.5 kc.

Linked to each camera is a minia-

Tiros Data

Weight	270 lbs.
Apogee	468.28 statute miles
Perigee	435.5 statute miles
Period	99.15 minutes
Angle of inclination	48 degrees



INTERNAL ELECTRONIC system of the satellite includes (foreground) one of the two TV cameras, surrounded by other subsystems, and (left and right) two specially developed magnetic tape recorders. AEP engineer is Robert Schmicker.

ture television magnetic tape recorder which stores 32 photographs on tape for later relay. Picture data can also by-pass the tape and be transmitted directly to the ground within range of a station. The Mylar-base tape is 400 feet long and moves 50 inches per second during recording and playback. The cameras and their equipment operate independently of each other.

• **Transmission & tracking**—During ground transmission, photo data is transmitted from one camera at a time and takes 3½ minutes per camera. The satellite is within transmission range of the ground stations up to 12 minutes. Connected to each photo system is a two-watt FM transmitter operating at a nominal frequency of 235.00 mc which relays picture information on command to ground stations.

Two readout stations are operated for the satellite: one by the Air Force at Kaena Point, Hawaii, and one by the Army Signal Corps at Fort Monmouth, N.J. They consist of approximately 15 bays of electronic control, transmitting, receiving and picture storage equipment. The antennas are 60-foot automatic tracking types with a command antenna on the outer edge.

The nickel-cadmium battery cells, which are actually overcharged by the solar cells, are hermetically sealed and rechargeable, and were developed by the Sonotone Corp. They can be recharged thousands of times and are designed to live as long as the satellite. Sixty-three Sonotone "F" cells, each three and one-half inches long and one and a quarter inches in diameter, and weighing approximately eight ounces, were used.

Data concerning the satellite's spin-axis attitude is provided by the infrared horizon scanner developed by the Barnes Engineering Co. The radially-oriented scanner senses the thermal radiation discontinuity between the earth and space. As the spin-stabilized satellite rotates, the scanner develops an electrical pulse whenever the thermal horizon crosses its field of view. Thus, as the scanner sweeps across the earth, two signals are produced—each one marking an edge of the earth. These signals are transmitted to the ground stations to provide data determining the satellite's attitude.

Two beacon transmitters, operating on 108.00 mc and 108.03 mc, both with a power output of 30 mw, will be used for tracking purposes. They can be modulated to provide information on satellite attitude, environmental conditions, and satellite equipment operation. For backup purposes, both frequencies carry the same data. Besides the two readout stations, the satellite will be tracked by the Minitrack fence.

• **Propulsion**—The *Thor-Able* vehicle used in the *Tiros* launching weighed more than 105,000 lbs. at liftoff.

The first stage was a conventional *Thor,* minus guidance and modified to receive additional stages. It generated 150,000 lbs. thrust for 160 seconds. The stage weighed more than 100,000 lbs. The Rocketdyne engine burns LOX and kerosene.

The second stage was an Aerojet-General *Able* that weighed 4000 lbs. Its 7700-lb.-thrust engine burned about 100 seconds. Propellants were unsymmetrical dimethyl hydrazine and white fuming nitric acid. It ignited immediately after first-stage separation.

Six small solid-propellant rockets, generating 130 lbs. thrust for a half-second each, spun the second and third stages just before separation of the third stage. The spin rockets, each about the size of an orange juice can, were manufactured by Atlantic Research Corp.

The second and third stages were separated about 1½ seconds after firing of the spin rockets. Then the third stage coasted for about 400 seconds. The solid-propellant third-stage rocket was manufactured by Allegheny Ballistics Laboratory, a division of the Hercules Powder Co.

The third stage weighed over 500 lbs., of which about 450 lbs. was double-base propellant, and about 50 lbs. was dead weight, including the laminated fiber glass-plastic casing. The rocket generated 3100 lbs. thrust for about 40 seconds.

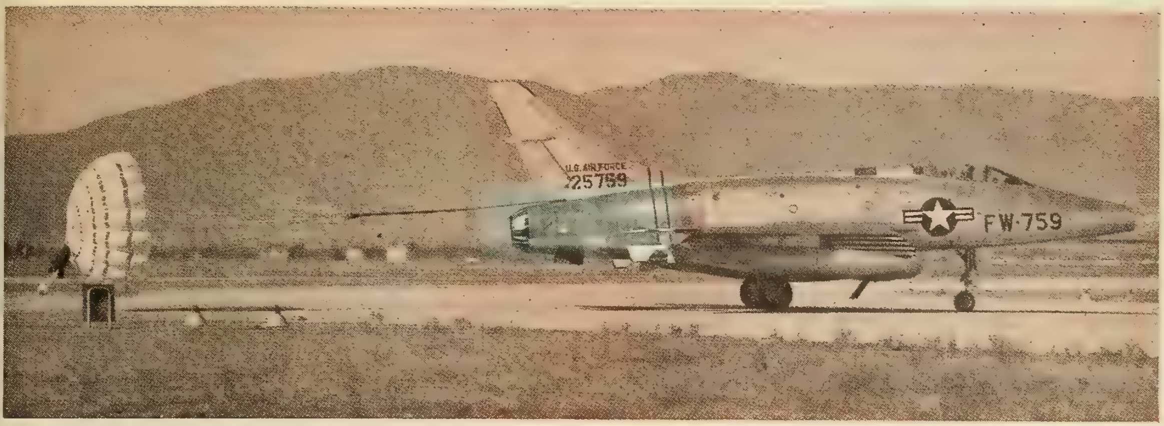
The payload was separated from the third stage by a set of springs about 25 minutes after third-stage burnout. Separation of first and second stages, and second and third stages, was accomplished with retro-rockets.

Six tiny solid-propellant rockets, also manufactured by Atlantic Research, are mounted on the satellite itself for firing at intervals to stabilize the orbit. The rockets are designed to produce 5 lbs. thrust each for 0.3 second. A pair will be fired about every 20 days to maintain the steady 9 to 12 rpm spin needed to keep the satellite properly oriented.

Atlantic Research said the tiny rockets would be the first to be fired by ground command after so long a period in space.

• **Nearly postponed**—Countdown of the first *Tiros* shot came within three minutes and forty-five seconds of postponement. A faulty telemetry beacon delayed the shot for a considerable length of time. Further delay was caused by a stuck valve in the ground support LOX equipment. The launch was finally executed at 6:40 a.m. Cutoff would have been at 6:43:45.

Heat Repulsed Here



Lightweight Silicone Laminates Withstand Continuous 750 F

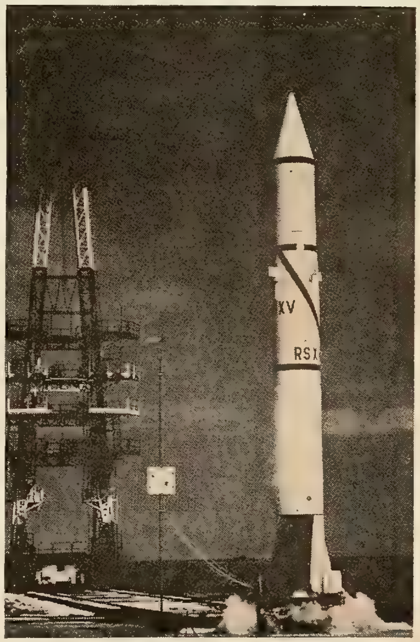
Ducts, pods, heat-shields, electronic components and other high-temperature parts for missiles or aircraft can be fabricated easily of lightweight silicone laminates. These laminates have good strength, good heat resistance, and are unaffected by moisture, weathering, ozone and corrosion, thermal shock or fungus attack. Dow Corning silicone resins, coupled with glass cloth or other inorganic fillers, give better strength-to-weight ratios "at temperature" than many light metals. And they're simple to form.

In the North American Aviation Super Sabre F-100, for example, designers needed a rigid material for the drag-chute case. As this chute case fits right up against the engine at the rudder base, the rigid outer wall of it must: 1) reflect heat away from the chute; 2) resist jet engine ambients; 3) retain structural strength without necessity of replacement.

Development engineers tried numerous "high-temperature" plastics without success. Too much heat. Then they hit on silicone-glass laminate, gold-metallized for heat reflectance. Not only did this prove entirely suitable, it also turned out to be more easily formed. The finished part can endure continuous service at 750 F and intermittent exposure to 1200 F. Vibration resistance is excellent.

Silicones for the Army Redstone

In the Redstone, Chrysler Missile Division engineers employ silicone laminates several ways. As in the case of the F-100, large heat shields behind the Redstone's engine compartment are fabricated of the laminates because of their light weight, heat resistance, thermal impedance. Also, due to excellent electric strength and creep resistance, silicone laminates are utilized for terminal boards in black boxes within the missile and in Ground Support Equipment control boxes.



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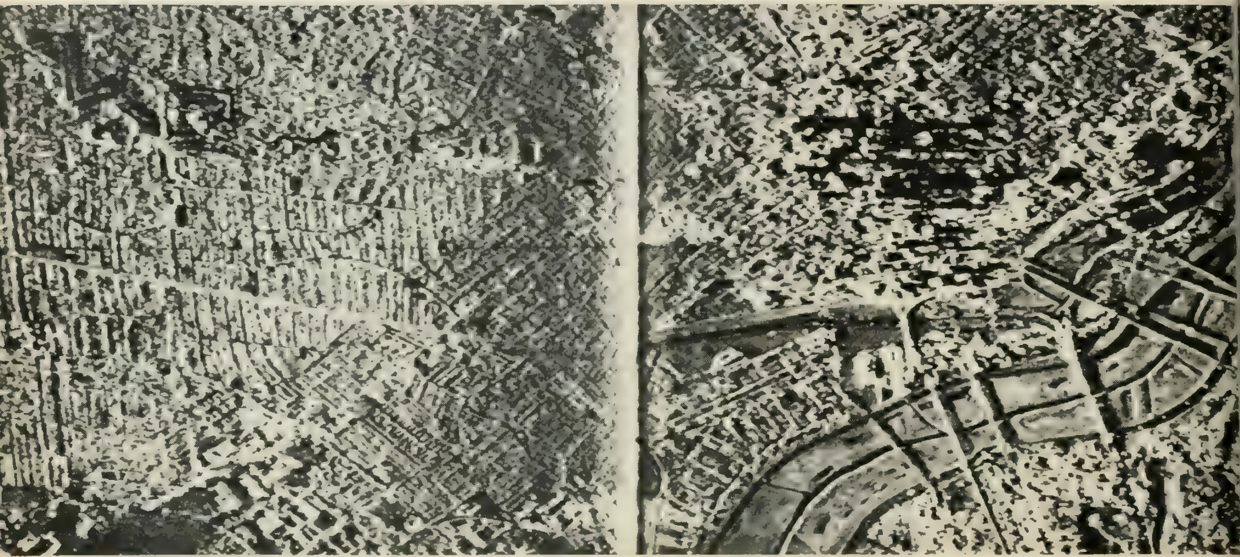
T-I Reveals Startling X-Band Radar



RADAR MAP of Dallas was made by Texas Instruments' AN/APQ-55 surveillance radar. Downtown Dallas is marked by radar shadows from skyscrapers. White line through center indicates path of mapping aircraft.

Details have just been released on a revolutionary side-looking surveillance radar developed by Texas Instruments for the Air Force. Designed for mapping and reconnaissance, the AN/APQ-55 can produce aerial maps of thousands of square miles per hour, night or day, in any flyable weather. The X-band radar gives field commanders near-photographic, up-to-the-minute information on enemy troops and material movements and pin-points targets in enemy-held territory.

Radar mapping provides surveillance data within moments after the surveillance craft makes its pass. A new microwave data link can transmit directly from the radar receiver and feed data back to a film recorder and processer at a remote combat post, to provide detailed photographs of the mapped area.

Development of the AN/APQ-55 was begun by Texas Instruments in 1955, under an Air Force contract, and completed and flight-tested within 16 months. The system is designed to map from either piloted or unmanned craft at ground speeds of 200-800 knots, simultaneously recording strips of terrain, either 3 or 6 miles wide, on both sides. A modified version will map 10- or 20-mile widths. Another modification will allow mapping at ground speeds up to 2200 knots.

Designed for low-altitude operation —1000-5000 feet—the system weighs only 350 lbs., with antennas. Key factors in the small size and light-weight achievement, according to TI, are the extensive use of transistors and a unique switching device that allows a single radar to look alternately from either side of the aircraft through side-looking back-to-back antennas.

Radar returns are displayed as a single modulated trace on a cathode ray tube and recorded on film. A film-pulling mechanism carries the film past the trace on the tube face at a rate proportional to the ground speed and altitude of the aircraft, producing a continuous, high-resolution film strip.

It's reported that an even more sophisticated system with greatly extended range is being developed and undergoing flight tests.

Star Radiation Seen As Space Navigation Aids

Future astronauts may use electromagnetic radiations from stars to determine speed and course on a long space journey, according to scientists at Franklin Institute. After a study just completed for the Air Force, the Institute reported that optical frequencies hold the greatest promise for early successful application to space navigation.

The proposed method is based on the doppler effect. Variations in frequencies received at the space vehicle from the sun or stars would vary in relation to the vehicle's velocity. Measurement of these variations would yield the vehicle's course and speed.

Signal levels of these natural radiations are very low, however, and significant advances will be required to produce equipment sensitive and compact enough to be carried aboard the space ship.

Some such navigation method is a necessity for future space travel. Radar is not suitable since it is effective only for relatively short ranges. The greater part of a space trip would be out of radar range of earth and destination.

Low-noise Receiving System Developed

The combination of a low-noise antenna and traveling wave maser developed by Bell Telephone Laboratories promises a significant advance in satellite-relay and long-range space communications. The system reportedly has a lower overall noise temperature than any other complete receiving system ever demonstrated.

Such a low-noise system could be used to extend the range or increase the bandwidth of telemetering equipment used for rocket probes into space. It would also extend the range of radio telescopes by an order of magnitude in detecting radiation from hydrogen gas emitted from far-distant galaxies. It would be useful in investigating interplanetary radio signals of all kinds.

Experiments with the antenna pointed vertically show an overall input temperature of 17.6°K at 5.65 gc (gigacycles, or kilomegacycles). According to Bell scientists, improvements under development indicate the feasibility of systems with a noise temperature of 7.5°K at 6 gc or of 5°K at 2 gc (reception near sky zenith).

For the low-side-lobe horn-reflector antenna pointed at the horizon, noise input rises to a value near 200°K. Therefore, the advantages of the low-noise receiver cannot be fully utilized in point-to-point earth communication. On the other hand, in space or satellite communication—where the antenna is pointed ten degrees or more above the horizon—the system gives a thirty-fold improvement over a conventional microwave receiver, which has an equivalent noise temperature in the neighborhood of 1000°K.

Based on measurements with the antenna pointed directly upward so that it intercepts a minimum of the earth's atmospheric envelope, the zenith sky temperature is about 2.5°K at 6 gc. Theoretical calculations confirm these measurements.

• **Horn-reflector antenna**—The receiving system uses a unique narrow-beamwidth highly directional horn-reflector antenna with low noise pickup from the surrounding terrain coupled to a low-noise traveling wave maser that amplifies in one direction only.

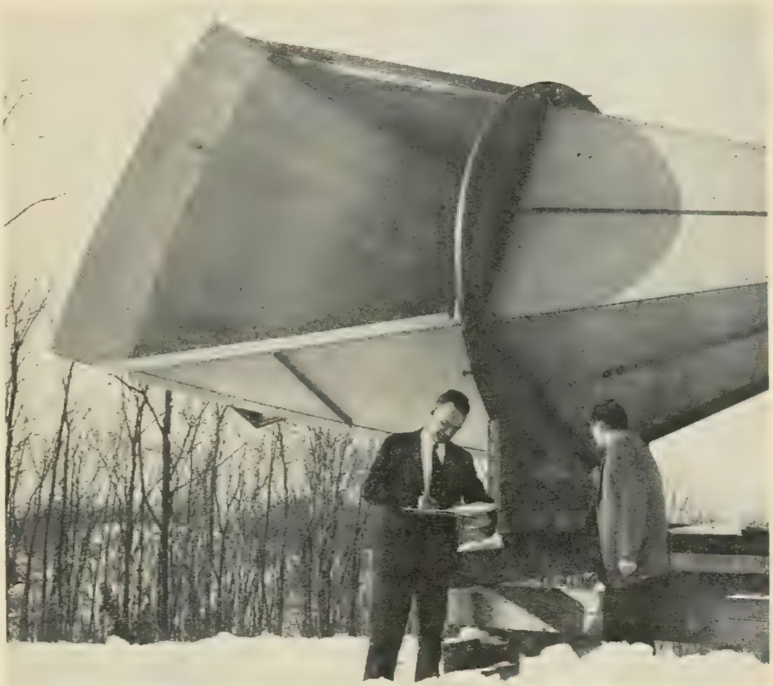
This antenna consists of a section of parabola fed by a rectangular horn. It was developed originally by Bell Labs for transcontinental microwave relays.

Because of the unique design, the lowest frequency of operation of the antenna is limited only by the size of the waveguide feed. The highest frequency is limited only by the mechanical precision of the parabolic surface.

The antenna can simultaneously handle the vertical and horizontal polarizations of the 4, 6, and 11 gc radio relay system with a return loss greater than 46 db (VSWR less than 1.02).

The experimental antenna is approximately 18 feet long, 6 feet high, and 8.5 feet wide. It has a radiating aperture of approximately 50 square feet, and a gain of 41 db at 5.65 gc. Side lobes (except those adjacent to the main beam) are down about 55 db and back lobes about 75 db on the average from the main beam.

• **Traveling-wave maser**—The traveling-wave maser used in the low-noise system was also developed at Bell Labs. With a bandwidth on the order of 30 mc, the TWM has sufficient gain to override the noise of a microwave crystal mixer. It is a two-port device designed to give unidirectional amplification in the forward direction only. Forward gain is 30-40 db and reverse loss 40+db. Pump frequency of the maser is 18.5-18.9 gc at 100 mw.



LOW-NOISE ANTENNA comprises a section of a parabola with a radiating aperture of approximately 50 square feet, and picks up relatively no noise from surrounding terrain. It has a gain of 41 db at 5.65 gigacycles.

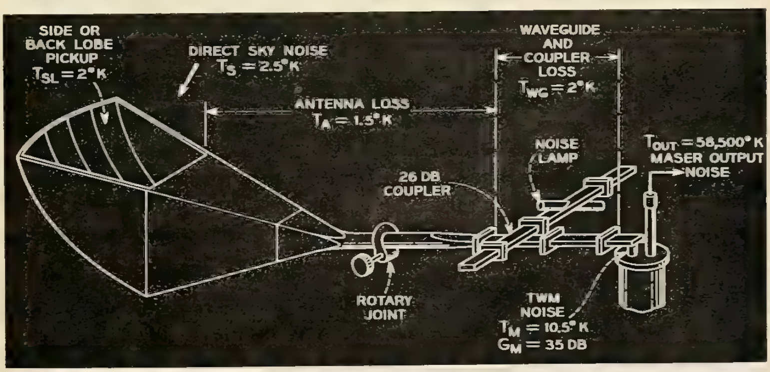


DIAGRAM OF TEST setup shows horn-reflector antenna, input waveguides and connection to traveling wave maser. Various sources and levels of input noise are also indicated.

DOD Handles Much *Mercury* Support

Use of military facilities and personnel to support the man-in-space project will save time and money

by Hal Gettings

PATRICK AFB, FLA.—International politics, economics, and interservice cooperation are all involved in the support program for Project *Mercury*.

Since economics is perhaps the major consideration, the National Aeronautics and Space Administration last August formally requested the Department of Defense to furnish certain equipment and services in support of *Mercury*. This was done, in the words of the House Committee on Science and Astronautics' first interim report on *Mercury*, "to avoid costly and time-consuming duplication." This solution was apparently a feasible one, and the program is moving along under a full head of steam.

Maj. Gen. Donald N. Yates, commander of the Air Force Missile Test Center here, was designated by the Secretary of Defense as DOD representative for *Mercury* support operations, responsible for all military forces, facilities, and assets assigned to the program. This includes the vast network of tracking, telemetry, communications, and monitoring facilities of the Atlantic Missile Range as well as other military-operated bases, ships, ranges, and communications facilities.

Also operating under the military will be civilian contractor operation and housekeeping personnel assigned to existing range stations as well as some new facilities implemented under the support program.

All three services will have major roles in the operation which has been cited as an outstanding example of interservice and military-civilian cooperation. The feeling among working-level participants seems to be that Gen. Yates is doing a remarkable job in getting the interservice team together and working well.

• **Army**—First missile-borne flights of the astronauts will be via Army *Redstone* boosters, modified to carry the capsule. A total of eight *Redstones* will be furnished, the first few of which will be used to fire unmanned capsules into ballistic trajectories. Later firings will carry the astronauts on short ballistic non-orbiting flights. *Redstone* launches will be from existing Complex 56 at Canaveral.

Other Army facilities to be utilized include White Sands Missile Range tracking equipment, and worldwide communication system. White Sands personnel will also operate NASA-provided equipment at the South Texas station. Army will assist in recovery of *Redstone*-boosted capsules and conduct test and launch operations.

• **Navy**—Prime Navy responsibility centers around recovery operations and hardware. It will provide ship and aircraft support for Wallops Island solid-rocket booster tests and the AMR *Atlas*-boosted tests.

FIRST space flight by astronauts will be made in *Redstone* boosters. Eight will be used to fire manned and unmanned capsules in short-range ballistic trajectories. (Retouched photo is artist's conception of mated booster and capsule.)

Commander, Naval Ordnance Test Unit, AFMTC, has been designated as deputy for recovery operations and naval support. He is responsible for preparation and execution of contingency plans for global recovery operations to cover the possibility of impact outside of designated AMR impact areas.

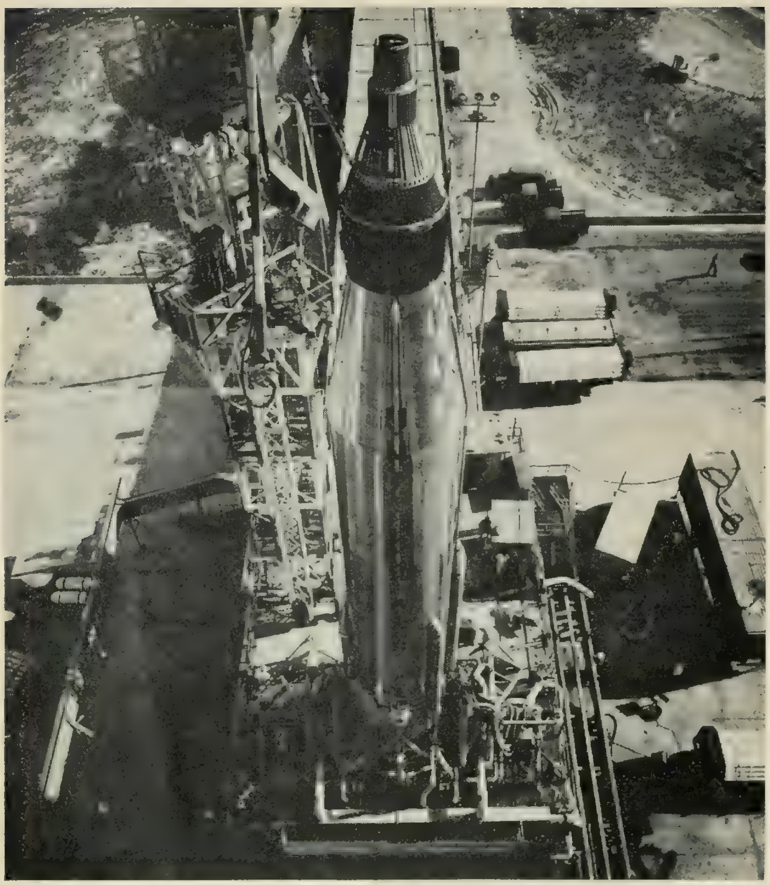
Services and facilities of Navy's Pacific Missile Range will also be used in support of *Mercury*. These include instrumentation for tracking, telemetry, communications, command control, and data reduction. Locations involved are Pt. Mugu, Pt. Arguello, and Hawaii.

Navy Seabees will be used for construction of facilities and support of mobile equipment on Canton Island in the Pacific.

• **Air Force**—General Yates has overall responsibility for the support program. The Air Force's primary contribution will be the AFMTC facilities, including Cape Canaveral and the Atlantic Missile Range, and some support from the Eglin AFB range instrumentation. AF will provide 13 *Atlas* boosters, launch crews and pads, tracking and communications instrumentation, transport, rescue service, recovery planning assistance test and data collection facilities, and direction of the bio-astronautics support.

• **Pan American World Airways and RCA Service Co.**—As AF contractors, these firms will operate the range ships and man, supply, and operate the other stations under Air Force cognizance. This work will be an extension of present AFMTC contract. Cape Canaveral support and similar operations, considered to be in the regular line of present range support, will be paid for by the Air Force. New large equipment items, new construction, etc., primarily for the *Mercury* program, will be paid for by NASA.

• **Bio-astronautics**—One of the major areas of military support for *Mercury* centers on the bio-astronautics—or space medicine—aspects of manned space flight. For many reasons, it was decided that this phase could best be



CAPSULE WILL be put into orbit with *Atlas* booster. Air Force will provide 13 *Atlases* as part of its contribution to Project *Mercury*.

handled by a military group—under NASA direction—backed up by a team of civilian and military experts as consultants.

Col. George Knauf—Yates' Assistant for Bio-Astronautics and AFMTC Staff Surgeon—heads a team of space medicine men from all three services.

These space medics will be located at each tracking station and virtually hold the astronauts' hands—via telemetry and voice communications—all during their history-making flights. According to Col. Knauf—a positive and sometimes controversial individual who looks more like a heavy-construction crew chief than an M. D.—"we'll get 'em up and back in good shape." And his conviction is convincing.

The primary function of the medics —officially designated "space surgeons" —will be to monitor the astronauts' physical characteristics—pulse, respiration, coordination, etc.—during flight. These characteristics will be continuously relayed by telemetry to display consoles at each station. In addition, they will use two-way voice communications to talk with the astronauts throughout the in-flight phase. On the basis of their observations the medics will keep the control center continuously advised as to the physical and psychological conditions of the man in space. They will give no orders, but their advice and recommendations will play an important part in NASA decisions affecting the flights.

In the post-flight phase, the bio-astronautics team will provide any medical care required, conduct a medical de-briefing, and reduce and evaluate the data gained for subsequent flights.

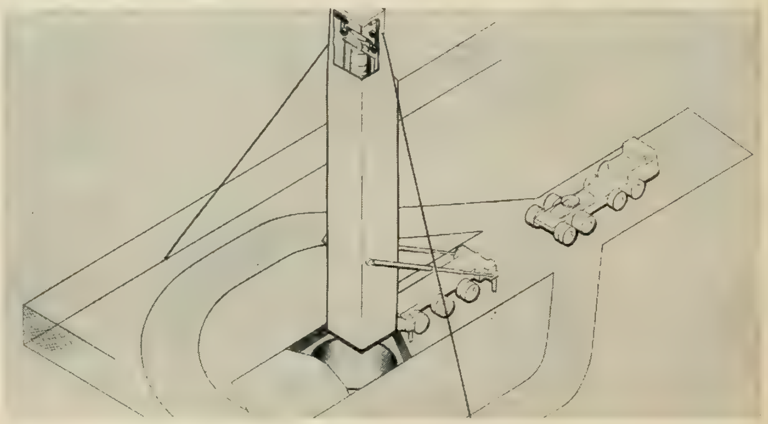
• **Doctors in depth**—The space surgeon will be a member of a three-man team at each tracking station (the other two: flight supervisor and equipment observer). These men—representing all three services and, possibly, even other countries—will be backed up by top-flight medical consultants, both military and civilian. In addition, considerable civilian talent will be used in the post-flight analysis.

First-line space medics, however, will all be military men. This is considered necessary due to the long-time requirements for training and operational phases during the project. In addition, it is desirable to maintain a trained cadre for future projects.

The space surgeons have already been selected on the basis of their experience. Plans are being formulated for extensive training of these and supporting medical personnel; the training programs were scheduled to begin about April 1st. A preliminary program was primarily concerned with acquainting senior Army, Navy, and Air Force medical officers with the problems involved and possible approaches to their solution.

Both Navy and Air Force have reserve training programs and resident schools in aviation medicine which are expected to provide a pool of space medics for future operations. AFMTC has been running one-week classes on the medical aspects of missile/space operations for the past 18 months; students are senior medical officers from all three services.

Minuteman Erector



MAJOR ELEMENT of transportation system for the Boeing *Minuteman* solid-fueled ICBM will be this large tractor-trailer combination called a transporter-erector, shown in recently released artist's drawing. The 63-ft.-long vehicle will haul the missile from assembly to launch site and lower it into the silo.

Temco Process Descales Titanium

LOS ANGELES—Industry is rapidly showing interest in a process for descaling titanium and its alloys after fabrication. The process, known as Ti-Brite, was developed by Temco Aircraft and is being marketed exclusively by Pennsalt Chemicals Corporation.

Increased use of titanium in the missile industry is expected to greatly expand the requirements for Ti-Brite processing, and Pennsalt says it has recently concluded an agreement with an unnamed customer for an "extremely large" installation.

At present, the world's largest such facility, with a tank length of 14 feet, is being operated by Northrop Corporation at its Norair Division.

Basic method used in Ti-Brite involves immersing the part in an electrolytic bath and subjecting it to an electric current of between six and 36 volts. The bath consists of an aqueous solution of hydrofluoric acid and a sulfate selected from the group consisting of the ferrous sulfates and aluminum sulfates.

Actually developed in 1957, the process has not seen maximum use, due to the hitherto limited use of titanium and the reluctance of companies to sacrifice present investments in processing equipment.

• **Safe and simple**—Tailored specifically to removal of oxide scale from titanium components after hot-forming or stress-relieving operations, the Ti-Brite process is reportedly safe, inexpensive and simple.

Unless expensive, elaborate precautions, such as inert gas atmospheres or chemical retardants, are used, the oxides of titanium form on the metal surface during fabrication and must be removed before further processing.

• **Standard methods**—Three standard methods used for scale removal involve immersion of the titanium part in a nitric-hydrofluoric acid bath, the use of molten salt, and various forms of abrasion.

The greatest disadvantage of nitric-hydrofluoric acid bath is that the action is considerably retarded by oils, greases, stamping inks and other materials used during plant processing operations. Manual effort to remove these materials is time consuming and expensive.

The molten salt bath involves a composition of the salts of the alkali metals, heated and maintained at a temperature above 700°F and usually at temperatures between 800° and 900°F. Close temperature control is essential, since a low temperature bath reduces the descaling reaction rate, and a high temperature bath may ignite the metal.

Disadvantages of the molten salt bath, therefore, are its high initial cost, high operational cost, close temperature control requirements, and the necessity for further chemical treatment to obtain a satisfactory surface.

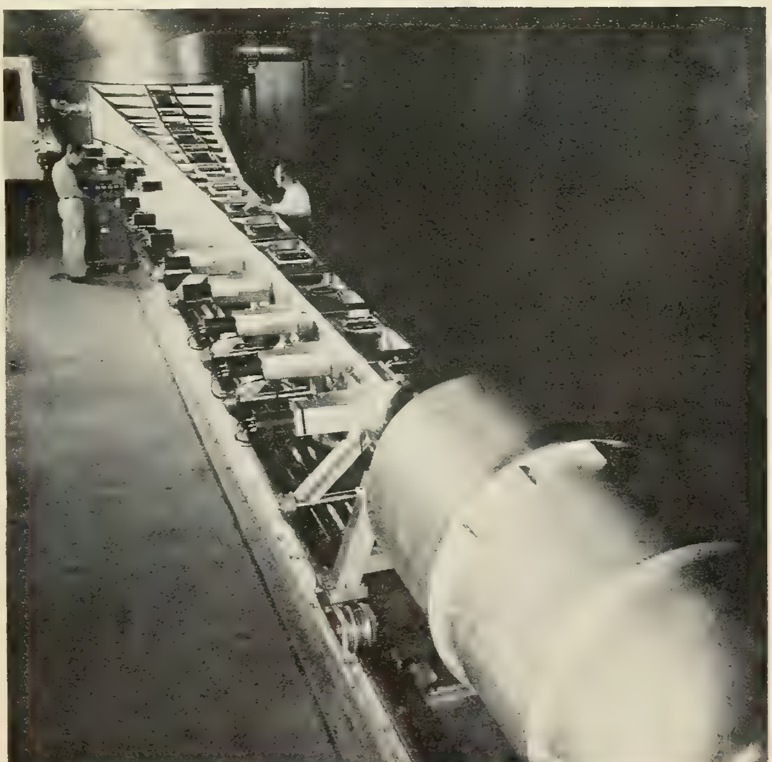
Abrasion methods for scale removal are usually applied to forgings or heavily scaled parts and employ grit, vapor blasting or grinding. These may impart a matte or scratched surface to the component and often result in discoloration.

• **Ti-Brite advantages**—Pennsalt's Ti-Brite process avoids all the disadvantages of these standard methods, plus performing more effective scale removal, according to the company.

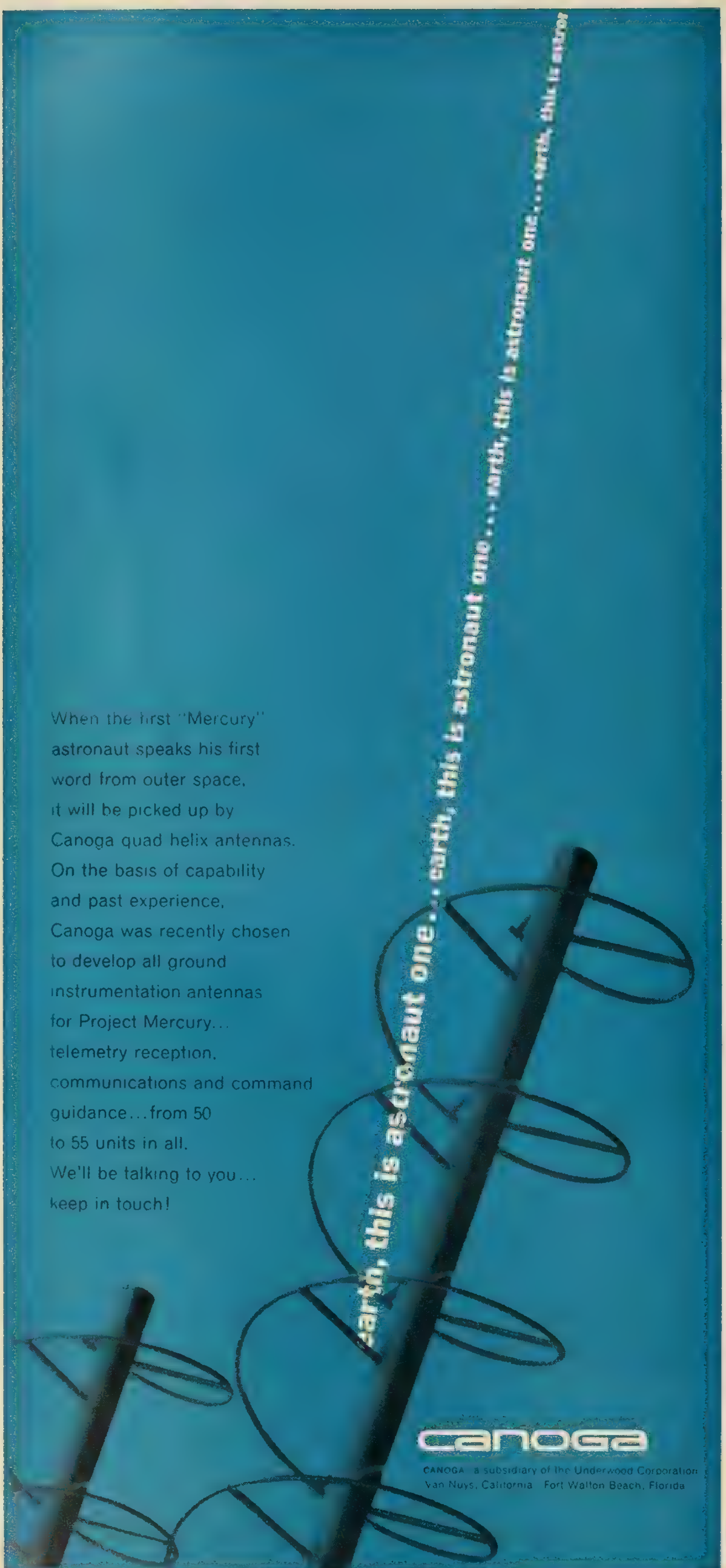
The process provides a method and a composition whereby titanium articles of substantially any size of configuration can be freed of oxide scale which forms in the temperature range of 400° to 1300°F. Upon completion of the process operations, the titanium is clean and bright, and requires no costly hand work.

Time required for the Ti-Brite oper-

Simulating Orbital Re-entry



MINIATURE TEST model to simulate orbital re-entry was fired in this Ames Laboratory simulator. Tank in foreground is high-pressure air source. At far end, pipe leads to vacuum sphere. **(Story on p. 30)**



ation depends on the current density, oxide scale thickness and bath concentration. Parts have been deliberately left in the working solution for periods of one hour, without any severe etching or gage loss.

Ames Center Simulates Orbital Re-entry

Orbital re-entry conditions have been simulated on earth for the first time at the National Aeronautics and Space Administration's Ames Research Center, Moffett Field, Calif.

The test model, about 0.25 in. diameter and resembling the *Mercury* capsule in leading edge configuration, was recovered after a short but eventful trip through the Center's Atmosphere Entry Simulator.

A series of shock waves inside a three stage gun, using helium as the propelling gas, ejected the model into the Simulator at 17,000 mph.

The simulator itself resembles a long, trumpet-shaped nozzle, which accelerates a flow of high pressure air so that there is a duplication of the thinning out of the atmosphere at high altitudes. At the widest section of the nozzle, low air density conditions typical of the beginning of a re-entry flight are maintained. As the nozzle narrows, air density increases, matching the environment of an actual flight. Temperatures in excess of 20,000°F were recorded immediately in front of the speeding model.

The miniature satellite survived all of the experiences of a full-scale vehicle returning from orbit.

• **Precise speed requirement**—The biggest headache in accomplishing this feat was achieving correct pressures, aim and velocities in the experiment. The test model was caught undamaged in a cylinder filled with foam rubber. If the model traveled too fast, it disintegrated in the "catcher."

There were other damaging effects if speed fell short of desired rate.

The recovered model was carefully weighed and analyzed. Less than 5% of the plastic ablation material had vaporized during the flight. Spark shadowgraph pictures were taken during the flight in order to study the shock wave and wake generated by the passage of the vehicle.

The test conditions were more severe than what the actual *Mercury* capsule will experience. This, in effect, was another confirmation of the type of heat shield selected for the manned orbit project.

Ames scientists and engineers are currently working on methods of duplicating in the laboratory the speeds expected of craft re-entering from lunar and planetary missions.

AC Seeks and Solves the Significant—Inspired by GM's pledge to contribute heavily to our national defense, AC, an acknowledged leader in the new technology, plans to reach far beyond such accomplishments as AChiever inertial guidance systems. / This is AC QUESTMANSHIP. It's an exciting scientific quest for new ideas, components and systems . . . to promote AC's challenging projects in guidance, navigation, control and detection. / Mr. Jack Briner, AC Director of Field Service, believes his department's Career Development Program "offers young engineers world-wide opportunities in the practice of Questmanship." They learn a product from its technological theory through its operational deployment. Following this training, "they utilize their own ingenuity to support AC products in the field, with more effective technical liaison through training, publications, maintenance engineering, and logistics." / You may qualify for this special training, if you have a B.S. in the electronics, scientific, electrical or mechanical fields. Special opportunities also exist at AC for men with M.S. and Ph.D. degrees. If you are a "seeker and solver," write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin.

GUIDANCE / NAVIGATION / CONTROL / DETECTION / AC SPARK PLUG *The Electronics Division of General Motors*

Bonus for Thermonuclear Research

Missile/Space cryogenic techniques should reduce costs and material needs in generating magnetic fields

by Jay Holmes

Rapid developments in cryogenic techniques resulting from America's missile-space program have generated an unexpected bonus in an entirely different field—the research on controlled thermonuclear reactions.

This development was outlined by Dr. Richard F. Post of the Atomic Energy Commission's Lawrence Radiation Laboratory recently, at one of a series of hearings on Frontiers in Atomic Energy Research before a subcommittee of the Joint Congressional Committee on Atomic Energy.

The thermonuclear reaction—the fusion of hydrogen-isotope nuclei as in the H-bomb—is considered desirable as a power source because it is "clean"—that is, there are relatively few radioactive byproducts. In the fission of uranium, plutonium and thorium, on the other hand, almost all of the fission fragments are radioactive.

Another advantage is the abundance of hydrogen, compared with fissionable material. In recent years, however, it has become clear that much more uranium is available than had been believed. Ultimately, thermonuclear power is expected to provide a form of propulsion for large interplanetary space craft.

• **Cheaper energy**—Improved cryogenic techniques, in addition to better metals technology and increased knowledge of electrical conductivity at low temperatures, will make possible huge reductions in the cost and amount of material needed to generate extremely intensive magnetic fields, Post told the committee. He explained the development as follows:

Since electrical resistance drops at low temperature, the power required to generate a magnetic field of given strength decreases. This does not involve the phenomenon of superconductivity, since superconductivity cannot exist in the presence of a high magnetic field.

A savings in the overall energy cost is possible, however, only if the cost of the power required to energize a refrigerated coil plus the cost of refrigeration is less than the cost of the ordinary coil at room temperature.

At very low temperatures—for example, 20°K—the limiting factor is the purity of the conductor. This meant that as recently as 10 years ago the possible improvement would not have made up for the large cost at the time of cryogenic refrigeration.

Now, however, very high-purity aluminum and high-purity sodium encapsulated in stainless steel tubes are available for windings. And the cost of refrigeration has been reduced to a small fraction of the former figure.

Post said a small test coil of refrigerated and encapsulated sodium has achieved a reduction in resistance of almost 6000 to 1. He remarked that the conductivity of the sodium becomes so high that, relatively, the stainless steel acts as an insulator.

The intense magnetic fields are needed in various devices to trap or contain plasma at temperatures in the tens of millions of degrees so as to light the thermonuclear fire in which heavy hydrogen nuclei fuse to form helium.

• **Thermonuclear reaction**—Another witness, Dr. James L. Tuck of the AEC's Los Alamos Scientific Laboratory, reported that a plasma reaction achieved in a machine built there has now been established as thermonuclear.

The machine, called Scylla, consists of two identical single-turn coils mounted coaxially along a shock tube and connected to a low-inductance capacitor bank. Magnetic fields up to 40,000 gauss were built up in the central region within about one microsecond, so as to shock-excite the gas to about 200,000°K. Then the result-

Spotlight on Materials?

ARMY SURPLUS searchlight was converted by engineers at Thiokol Chemical's Reaction Motors Division to a solar furnace for testing material properties at high temperature. Dr. Stanley Tannenbaum, Dr. Frank Loprest and Steven Tunkel are shown adjusting the furnace, which can produce temperatures of 6300°F at ¼-in. focal spot. Electronic couplings enable furnace to track sun automatically and control temperature at sample.

ing plasma was further heated by compression. Radio frequency excitation provided partial ionization of the gas before beginning the shock.

Results from the Scylla machine were reported at the 1958 Geneva atomic energy conference, Tuck said, but Los Alamos did not have enough information at the time to be sure that the flow of neutrons was the result of a thermonuclear reaction. "We really think it is thermonuclear now," he said, adding:

"We seem to have a plasma of hot deuterium in the form of a small egg-shaped fireball about 2 cm. in diameter, containing about 5×10^{16} deuterons/cc with a temperature of 1.3 ± 0.1 kev. The electrons have a temperature of about 240 electron volts and the fireball lasts about 0.9 microsecond in the original Scylla I apparatus and in this time it emits about 10,000,000 thermonuclear neutrons."

• **Much still to be done**—A more advanced machine, designated Scylla II, uses two magnetic squeezes, a fast one and a slow one, and extends the duration of the neutrons to about 7 microseconds, he said. A still larger machine probably will be built, he added, but in the meantime much study of Scylla II is necessary.

The energy attained to date is far from the amount necessary for a self-sustaining thermonuclear reaction, which would generate more energy than is put in. Dr. Arthur E. Ruark, chief of the AEC Controlled Thermonuclear Branch, said a deuterium-tritium plasma must be heated to a temperature of at least 50 million degrees, which is equivalent to a particle energy of about 5,000 electron volts.

"It is my belief that we shall obtain thermonuclear temperatures in a relatively short term of years," Ruark declared. "This belief is not to be confused with the general verdict of thermonuclear physicists that 10 to 20 years might be required for development of the first fusion powerplant. Indeed, no one can say with certainty that this second step will be feasible. The answer depends on further study of extremely hot gases, squirming and turning in every way to escape the imprisonment we seek to force upon them."

AEC Designing Follow-On Reactor for *Kiwi* Series

The Atomic Energy Commission is designing a follow-on reactor to the *Kiwi-A* series *(Kiwi-A, Kiwi-A Prime, Kiwi-A3)* as an advanced phase of the *Rover* nuclear rocket program.

Kiwi-B is scheduled for operation

in 1961 at the Nevada test site of the Atomic Energy Commission. It is still on the drawing board, and its design has not yet been frozen. *Kiwi-B* will take advantage of the knowledge gained from the *Kiwi-A* series.

Meanwhile, the second reactor in the Project *Rover* program will be assembled and ready for initial tests at Los Alamos Scientific Laboratory by mid-summer. The assembly operation is expected to begin this week on *Kiwi-A Prime* at the laboratory (M/R, April 4, p. 24).

LASL currently has about 50 personnel manning its Nevada Test Site on the *Rover* program. Their principal interest now is revising the existing system to meet the requirements of the two latest reactors, and simplifying the actual operation and control of the new reactors as much as possible.

A second test cell, dubbed Test Cell C, is scheduled for completion in early 1961. Work on the communication and utility facilities for this installation has already begun. This cell will be similar to Test Cell A but will permit more sophisticated experiments. Test Cell C will be located about a mile west of the present test site and about two miles north of the *Rover* control point.

It is anticipated that the cost of the new cell will be about $8-million. Contracts have been let for extension of a railroad, a vehicle road and a water line to the installation. The first major construction contract will be awarded within a few months.

NASA Plans to Renew Bell's H-F Rocket Engine Contract

The National Aeronautics and Space Administration expects to renew the Bell Aircraft Corp. contract for developing a liquid fluorine-liquid hydrogen rocket engine, it was learned last week.

Bell recently static tested an H-F engine up to 17,000 lbs. thrust. Chamber pressure was about 250 psi.

The Niagara Falls, N.Y., company has been working with fluorine engines since 1956. Last spring, NASA granted Bell a $1,070,000 one-year contract to continue the work, originally funded by the Air Force.

This year, it was learned, NASA plans to renew the contract for nine months, at a cost of about $700,000.

Hydrogen and fluorine provide the highest specific impulse of any known chemical combination. At an oxidizer/fuel ratio of 4.5/1 and chamber pressure of 500 psi, the combination theoretically yields specific impulse of 373 seconds—about 13 seconds greater than the hydrogen-oxygen combination.

The major problems in using fluorine as an oxidizer are its high cost ($2.65-$3.75 a pound), difficulty of storage, and corrosive combustion products. NASA liquid rocket specialists see the major application of hydrogen-fluorine engines as final stages in large vehicles such at *Saturn*.

Hughes, NA, Ford Design Rough-Land Moon Capsule

Hughes Aircraft Co., North American Aviation's Missile Division and Aeronutronic Division of Ford Motor Co. have been chosen to make competitive designs of a 300-lb. capsule for a rough landing on the moon.

Jet Propulsion Laboratory of California Institute of Technology chose the three from 14 companies invited to bid on the design for Project Ranger, under which the National Aeronautics and Space Administration plans to land a package of scientific instruments on the moon's surface.

The studies are to be completed in six weeks.

Grand Central Fires Nitrasol Grain at -75°F

Grand Central Rocket Co. reports a completely case-bonded, cast-in-place grain of Nitrasol propellant has been temperature-cycled repeatedly from –75 to 165°F and successfully fired at –68°F.

Irwin Spitzer, GCR engineer in charge of Nitrasol development, said that until the recent achievement, "no really high-performance rocket motor ever had been made that could be fired successfully at low temperatures after temperature cycling."

The size of the experimental motor was not given. However, Spitzer said continually larger Nitrasol motors will be tested.

Successful Test Made of B-58 Escape System

The rocket-catapult assembly for the escape system of the B-58 Air Force Mach 2 bomber was tested successfully March 29 at the Hunter Bristol Division of Thiokol Chemical Corp., Bristol, Pa.

J. S. Jorczak, Hunter Bristol vice president for specialties operations, said the complete unit, conditioned to 160°F, completely fulfilled design requirements.

Thiokol manufactures solid-propellant rockets to catapult the escape capsule, which Stanley Aircraft Corp. is developing for Convair Division of General Dynamics Corp.

AIR DEFENSE against submarine threat rests largely today on Lockheed Neptunes and Grumman Trackers.

The ASW Threat:

The Sea Is Never Neutral—She Favors Only Those Who Understand Her Best

by William Beller

Suddenly the U.S. has awakened to a new threat—attack on its shores by missile-bearing submarines. During the appropriation hearings going on, Congress says it wants something done about it now and is willing to spend over a billion dollars for the work. The Navy answers that the problems are tough and even money may not buy the solutions.

The Sea is never neutral. She favors those who understand her best.

For a while, this understanding meant leaving her alone. This served our Republic well in her early days. During peace time, she was insulated from the squabbles going on in Europe and Asia. And when war came, she had thousands of miles of water that kept her cities and countryside from being invaded.

During the early months of the First and Second World Wars, the United States was surprised to learn that her oceans were not as fine an insulation as she had thought they were. German submarines were coursing freely through them, destroying thousands of tons of shipping and nearly defeating the Allies at the same time.

Each time the United States was taught the partisanship of the Sea, but the learning has come hard. Even now, the Navy not only admits but also announces to anyone who will listen how little the service understands about the medium over which she sails.

"We know less about the ocean than we do about the moon."

"To detect hostile ships, we are still using the means first enunciated by Leonardo da Vinci over 450 years

SEA DEFENSE is the hunter-killer task force represented here by USS Valley Forge, flagship of Group Alpha, and escort craft.

ago.

"We know the terrain under less than two percent of the world's seas."

• **Threat and counterthreat**—One reason for this negative boasting is clear. The oceans have become a conductor for rather than an insulator against enemy attack. To deter or counter this threat, the Navy is asking Congress this year for nearly $1.4-billion for antisubmarine warfare.

Two new factors entering the ASW scene are calling for a budget this large. The nuclear-powered submarine is here and it works very well. Although the United States is the only country having such craft now, the Soviet Union is building similar ships and will have them operating soon.

The second new factor is the emergence of a submarine-launched IRBM, for the United States, the *Polaris*—in effect, a global range missile.

Two years ago an Underseas Warfare Advisory Panel advised the Joint Committee on Atomic Energy that "The day is rapidly nearing when the Soviet can possess, first a few, and then a large fleet of intermediate-range ballistic missile-launching nuclear-propelled submarines." The Panel ominously concluded, "Our existing and presently planned defensive system could not stop such a missile attack." Today the statement is still true. Herein lies our great peril.

If we turn the coin, we see we have the very weapons in being that the Soviet still has in development. We have more. In the *Polaris* we have a weapon system that as far as anybody can see today is close to invulnerable. Herein lies our hope.

• **Three problems**—The Navy thus has three big problems. One of them is as old as the service itself, and two are modern ones.

First, how can the Navy keep the sea lanes open? There can be no compromise here. The lifeblood of the Free World nations circulates through the oceans. Note that a week after the start of the Suez crisis and resulting restricted shipping, Europe was out of fuel and desperate!

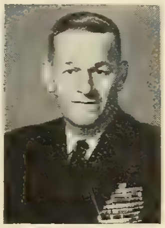
There are many impressive statistics, each gravely reflecting what would happen if shipping were interfered with. The most significant seem to be these: The Soviet operates about 60% of the world's submarines but, with her satellites, accounts only for 10% of all merchant shipping. Obviously, the USSR submarines are meant to hit the Free World where she is most vulnerable.

In the instance of the Korean conflict, a limited war condition, imagine our consternation had our 5000-mile pipeline bringing men and materials

Commends M/R's ASW Effort

Adm. Hayward Answers: The Challenge of ASW

Vice Admiral J. T. Hayward, Deputy Chief of Naval Operations for Development, is a man greatly concerned with the rising threat of the missile submarine and how to counter that threat.



Although forbidden by Defense Department public relations policy from signing or bylining stories for the public press, he has transmitted to M/R the following views on the question, "What is the Challenge of ASW?"

"In two world wars the submarine played an important role, yet it was not a submarine in the true sense of the word but rather a surface ship that could submerge. For a matter of fact a large percentage of the attacks by submarine were made on the surface with the submarine only submerging to avoid counterattack.

"Since World War II we have seen a marked change in the character of the submarine both operationally as well as technically. Operationally, it is now capable of attacking land installations with powerful atomic missiles where before it was only a menace to shipping. Technically, it has become a true submersible capable of sustained underwater operation and high submerged speeds. Where in World War II a submarine could be held down by a relatively small number of ships and planes until exhaustion, today the submarine is capable of indefinite submergence and speeds equivalent to the surface craft designed to hunt and kill it. Its volume of operation has been increased both by greater speed and greater submerged depths.

"Thus the submarine, always an elusive foe, has acheived new proportions as to its deadliness and evasiveness. These new characteristics are taxing the Navy's ingenuity and it is with pride and hope that we see industry willing to share this burden with us.

• **"Liquid space"**—Although outer space serves to hold a hypnotic attraction to this generation probably because it is the great unknown, the exploration of liquid space is just as difficult and requires similar scientific disciplines. It is shocking to realize that we know less about the ocean as a medium than we do of outer space and yet approximately 70% of the earth is covered with water. Space may hold the answer to the earth's origin, but some believe the sea holds the answer to man's past and probably his future.

"At any rate the submarine has focused the Navy's attention on how little is known about the oceans below the surface. The problems are analogous to those found in missiles and rockets; that is why it is heartening to know that interest is being shown by people versed in this field. As an example there is sufficient similarity in the following areas to warrant people trained in one to look at the other. Hydrodynamics versus aerodynamics, power in rarefied air versus power under terrific pressures, transmission of electromagnetic waves through the ionosphere versus acoustic energy through temperature gradients, structural strengths of acceleration versus structural strength against pressure, meteorology versus oceanography.

"The submarine offers a challenge to all scientific endeavors and it is only through a mutual understanding between the Navy and industry coupled with a desire to cooperate with each other towards a common goal of national security that problems as large as that of antisubmarine warfare can be solved.

"It is encouraging to see MISSILES AND ROCKETS take an active interest in the field of antisubmarine warfare and we in the Navy are looking forward to the interest that we expect will be shown by the readers of the magazine."

across the North Pacific been cut!

Second, how can we prevent missile-launching submarines from threatening continental United States? The danger can be imminent.

Third, how can we exploit the *Polaris* so that it will be used to the fullest extent as a major deterrent to war? There are political answers. The technical ones, if we admit needing an enlarged *Polaris* force, is how best to develop, build, operate, disperse and maintain such a fleet.

• **An all-Navy job**—Antisubmarine warfare is a major Navy mission. There is no doubt about this when one sees that the service will be apportioning nearly 30% of its Procurement and RDT&E FY 1961 budget for ASW work.

In ASW operations, the task is to detect, localize, identify and be ready to destroy underseas enemy craft. To do this, every facility in the Navy is needed. This includes surface as well as underseas ships, aircraft, ordnance and ammunition, electronics equipment, and the services of applied and basic research. The job demands full resources of both industry and the Navy.

...tools the Navy needs in ASW

Rear Admiral H. A. Yeager, CNO's antisubmarine warfare readiness executive, recently told the House Appropriations Subcommittee that, "Our exercises have revealed that with highly trained personnel, current ASW techniques are effective against conventional diesel-electric submarines." He added, in understatement, "Destroying the high-speed nuclear sub and the submarine-launched missile are more difficult problems."

He might have emphasized how extremely sensitive ASW searching is to the personnel doing the work. Ocean noise and the poor resolving power of acoustic waves lead to more killed whales and porpoise schools than "hostile" targets.

• **Tools demanded**—To meet the challenge of Soviet underseas weapons, Yeager says that his service needs:

Intelligence on Soviet submarines.
Increased detection ranges.
Improved localization ability.
More rapid classification techniques.
Higher speed ASW vehicles.
More early attack weapons systems.
Additional ASW forces.

To satisfy these needs, the Navy is proposing a $1.364-billion budget for direct ASW work. A big piece of this budget, 56%, is for ship construction and conversion. The Navy wants 13 additional ships, modification of the submarine *Albacore*, and 14 World War II destroyers updated.

In the breakdown, the program looks like this:

• The Navy wants in FY 1961 to buy three guided missile frigates and two guided missile destroyers, all with long-range sonar, *ASROC* missile systems and homing torpedoes.

• The Navy wants two improved destroyer escorts. These will have "new sonar equipment, expected to provide much improved detection ranges on submarines," will be equipped with *ASROC* and, in addition, with a drone helicopter for weapon delivery—the DASH system.

• The budget also calls for three nuclear-powered attack submarines similar to the four that Congress provided for in the FY 1960 budget. Those will have sonar systems, for both passive and active detections, will carry high-speed torpedoes, and perhaps *SUBROC*.

• One oceanographic research ship, designed as a mobile laboratory, will be built to study effects of environment on sound transmission.

• An escort research ship will be built to evaluate new hydrodynamic and propulsion designs. This craft will be doing for future surface craft what the whale-shaped experimental submarine Albacore has done for modern submarines—will be giving naval architecture a scientific boost.

• Albacore, which initiated the family of high-speed submarines of new hull design, will be having another research modification.

• An experimental very deep-diving submarine is included to explore the fields of deep submergence, and its effects on extremely long-range detection and attack capabilities.

• Fourteen World War II destroyers will be given new sonars, the drone-helicopter system, *ASROC*, and new torpedoes.

Total cost of this shipbuilding program, including development work, will be $762.3-million.

AIRCRAFT

After ships, the largest part of the ASW budget, a quarter of it, will be spent on aircraft and ASW equipment associated with aircraft. The Navy will be buying Sikorsky HSS-2 helicopters, Grumman S2F-3 fixed-wing carrier-based aircraft, Lockheed turboprop P3V patrol planes, and for the destroyers, Gyrodyne's gas-turbine-driven DSN-3 drone helicopters. The Navy also will be using some money for modernizing its present patrol and carrier-based fixed-wing aircraft. The ASW aircraft procurement program amounts to $340.1-million.

RESEARCH & DEVELOPMENT

A little more than 13% of the ASW budget will be going into Research, Development, Test and Evaluation. A third of this money will be used to find some way to improve the Navy's detection, classification and localization equipment. Unless more sensitive and discriminating search techniques are found, the service will have to keep on supporting forces in numbers to make up for lack of forces in perception.

Research in acoustic energy is being pushed because it is the only one that is expected to yield significant dividends in improving detection. Of the more than 100 ASW research projects, about half are concerned with acoustics and oceanography.

The oceanography programs, which are coordinated efforts of Naval and civilian laboratories, are supporting 16 research ships. In FY 1961, the service plans to allocate $17.7-million to the subject, an increase of $4.2-million over FY 1960.

In the vehicle and propulsion research areas, work is being done on reducing the size of nuclear reactors and in developing small gas-turbine engines. The total RDT&E FY 1961 budget calls for $180.5-million.

Filling out the ASW portion of the Navy budget is an ordnance and ammunition appropriation for $56-million, and major electronics procurement for $25.5-million.

ORDNANCE

The most important influence in ASW ordnance and ammunition is the Navy's eagerness to get a good attack capability at the earliest possible moment. Suiting the deed to the wish, the Navy says that this summer the Fleet will be getting for the surface ship a "rocket-assisted weapons delivery system which will employ either a homing torpedo or a nuclear

depth bomb as a warhead," the *ASROC.*

The Navy is limiting its ASW torpedo procurement to four types. Two of these are homing torpedoes, one of which will be used by surface ships and submarines, and the other by surface ships and aircraft. Their targets will be advanced submarine types. The third torpedo is a submarine-launched type of advanced design. The fourth torpedo, which is expected to match advances in nuclear submarine design and performance, is being bought for testing. Its operational evaluation will begin early in 1962.

With these facts in mind, Admiral Yeager assured the House Appropriations Subcommittee that "By 1963 we will have standardized our torpedoes for aircraft, surface ships and submarines. These torpedoes should be capable of destroying the best enemy submarines producible over the next ten years."

The Admiral pointed out the need for greatly improved submarine-laid antisubmarine mines. He told Congress, though, that he believed the Navy had just such a mine in the newly developed MK 57. Part of the budget money will therefore be used for evaluating this weapon.

ELECTRONICS NEEDS

Major ASW electronics purchases are of three types. The first is for variable depth sonars, which will be going into the older destroyers. This equipment will let these ships lower sonar transducers below the thermal layers. These layers are temperature gradients in the ocean which, unhappily, can tremendously reduce the effectiveness of hull-mounted sonar equipment.

The second item is a new high-powered surface-ship sonar, which is being bought for back-fitting to the newer destroyers, to give these ships modern ASW capability. The third item is for communication and training equipment.

Dr. J. W. Horton, in his book *Fundamentals of Sonar,* Naval Institute Publication, points out that around the time Columbus was sailing to America, Leonardo da Vinci made the following entry in his scientific notes:

"If you cause your ship to stop, and place the head of a long tube in the water, and place the other extremity to your ear, you will hear ships at a great distance from you."

Any other description of a sonar system differs only by the addition of details, remarks Horton. It is still necessary to stop your ship if you intend to hear "ships at a great distance from you." The only addition in principle not included in da Vinci's statement is the provision for causing an otherwise silent target to become a secondary source of acoustic energy.

• **Limitations**—Chances for finding a detection principle that will improve upon da Vinci's are slim. Light and other electromagnetic radiations penetrate water only a short distance. The only useful "window" that has been found in water is in the acoustic band. And here, maximum detection range of an object is given in terms of thousands of yards, a poor parallel for radar sight.

There are other disadvantages to acoustic or sonar detection means, which it appears the Navy must live with. The speed of an acoustic wave in water is slow, carrying a pulse only 250 yards in the time it takes a radio wave to circle the globe.

In addition, because acoustic wave lengths are long with respect to those of light, about a quarter of a million times longer, sonar detection is poorly descriptive. For example, the number of rivets in a ship's hull can be counted if exposed to light, whereas only the ship itself might be discernible if perceived by acoustic means. Even then, it is frequently difficult for the sonar operator to discriminate between a small ship, a whale or a school of flying fish. The dilemma of the Navy commander is obvious.

• **Deeper problem**—Even so, Navy experts say they are not too worried about detecting diesel-electric submarines. They are relatively noisy, have fairly well-defined noise patterns, do not go very deep, nor travel very fast. It is the nuclear submarine that is nearly invisible. It goes almost silently, travels deep and travels fast. It is also the most lethal.

There are two basic types of sonar detection systems. The first is the direct-listening type, a passive system.

ASW PORTION OF NAVY APPROPRIATION
(in millions)

Navy Appropriation	FY 1959	FY 1960	FY 1961
Shipbuilding and conversion	$1,012.6	$ 485.7	$ 762.3
Aircraft and related procurement	266.3	476.8	340.1
Research, development, test and evaluation	202.7	225.3	180.5
Procurement of ordnance and ammunition	54.1	50.2	56.0
Major electronics procurement	60.1	37.9	25.5
Total, all appropriations	$1,595.8	$1,275.9	$1,364.4

BREAKDOWN OF FY 1961 ASW PORTION OF NAVY BUDGET
(in millions)

Shipbuilding and conversion		$762.3
3 (DLG) guided missile frigates	231.6	
2 (DDG) guided missile destroyers	92.5	
2 (DE) improved destroyer escorts	50.5	
3 (SSN) nuclear-powered attack submarines	171.6	
1 (AGOR) oceanographic research ship	4.9	
1 (AG) escort research	29.3	
1 (AG) deep diving	25.8	
14 (DD FRAM, MK 1) WWII destroyers conv.	142.1	
1 (AG) SS Albacore, conv.	14.0	
Aircraft and related procurement		$340.1
HSS-2	....	
S2F-3	....	
P3V-1	....	
DSN-3	....	
Modernization of A/C	....	
Sonobuoys	....	
Command and control (Incl. Trng.)	....	
Research, development, test and evaluation		$180.5
Classification, detection and localization	63.4	
Weapons, ordnance and fire control	64.2	
Vehicles and propulsion equipment	29.6	
Collateral, supporting and related equipment	23.3	
Procurement of ordnance and ammunition		$ 56.0
Missiles and support	....	
Depth charges	....	
MK 37 Torpedo and support	....	
MK 44 Torpedo and support	....	
MK 45 Torpedo and support	....	
MK 46 Torpedo	....	
Torpedo support (in service torpedoes)	....	
MK 57 Mine	....	
Fleet service mine test	....	
Miscellaneous ASW ammo	....	
FRAM support	....	
Major Electronics Procurement		$ 25.5
Sonar and detection equipment	22.0	
Communications	2.6	
Trainers	0.9	

WORLD'S LARGEST amphibious helicopter, Sikorsky's HSS-2, conducts dip tests of its sonar detection gear.

Here the target generates the signal being picked up. It is a simple system requiring only a transducer to convert acoustic energy into electrical energy. It can be made a directional system merely by maximizing the acoustic energy received. If two transducers separated by some distance are used, then triangulation can give the target's range.

The detection distance depends upon the acoustic energy output at the target and background noise. If the noise characteristics of the target are known—and this is a constant Navy study—then the sonar can restrict its listening to appropriate frequency bands. This technique gets rid of some of the background noise, and consequently gives a longer range.

SONOBUOYS

One of the most effective devices we have today for keeping track of underwater sound is the sonobuoy. This is an expendable and short-lived floating FM broadcasting station, dropped from aircraft over the area being surveyed. Upon impact, the sonobuoy automatically drops a microphone or hydrophone for submarine detection, and raises an antenna for its contact with the aircraft. Range of the sonobuoy is short, variously estimated at between 3 and 30 miles, and its cost is nominal, averaging about $160.

However, the Navy is having some problems with sonobuoys. Their reliability is less than what is wanted, particularly in the "shelf life" regime. For this reason, some sonobuoy money will be put into reliability studies. Specifications will be tightened up so that manufacturers will be turning out standard products. Specifically, this means that sonobuoys will have to meet not only performance specifications but also detailed ones.

• **New approaches**—There is in the works the concept of relatively long-life sonobuoys for anchoring in the floor of the ocean at strategic points or in telling patterns. Such systems are said to be related to the highly classified *Artemis* and *Atlantis* systems. Navy officials disclosed late last month that work was nearly completed on Project *Artemis*, which they said is a study to establish the feasibility of ocean area surveillance. It is believed that such a surveillance would be made by active sonobuoys distributed along the Atlantic continental shelf.

Project *Atlantis* is believed to relate to ensonifying and using for submarine surveillance the transatlantic cables. In this view, it does not seem odd that several months ago a Russian trawler "accidentally" fetched one of the cables up in their fishing nets.

The second sonar detection technique is that of echo-ranging. This is an active system particularly useful against relatively silent targets.

In this system, an acoustic signal is sent out and its echo listened for. If there is a reflecting body within range, then the echo time delay will tell its distance; and the maximized signal, its bearing. The problems here are in accurately knowing the velocity of sound in water, particularly in view of the many variables involved; and also in being fairly certain that the echo is not coming from some ocean-bred phenomenon that gives rise to reflected acoustic signals.

STRIPPERS

Put a high-pressure sound in the water and it can be heard for hundreds, perhaps a thousand miles. This is the basis behind explosive echo-ranging. Used in this type detection are the "stripteaser" series of sonobuoys. Julie and Jezebel are two examples. These are amply described by what is purported to be the derivation of their names, said to belong to Philadelphia burlesque queens who were able to make active that which was passive.

Underwater communication, another sonar technique, is merely an echo-ranging system in which a vocal signal is substituted for a pinging one. Because sound is such a slow traveler, in underwater telephony between stations only a mile apart, operators experience a six seconds' lapse between the end of a transmission and its subsequent reception. How much can happen to a submarine in six seconds!

OCEANOGRAPHY

Since the entire ASW effort is built upon having a knowledge of the sea, the Navy in FY 1960 embarked on a ten-year oceanographic program—TENOC. This is a contract research program paralleling similar work being done in Navy laboratories. R&D funds required for this program, and approved by the Chief of Naval Operations, increase from about $10-million in FY 1960 to almost $28-million in FY 1969, totaling a little over $190-million for the decade. Besides, the TENOC program is asking, in round figures, for $12-million for buildings, $52-million for 18 oceanographic research ships, and $1-million for pier construction. This brings a total of all TENOC funds for the decade to over a quarter of a billion dollars. It has been emphasized by the Navy that this program is in direct support of ASW. Work will be stressed in the following areas:

• General circulation of the oceans.

• Horizontal and vertical diffusion, that is, density stratification.

• Salinity and electrical conductivity.

• Compressibility and sound velocity.

• Characteristics of noise producing animals.

• Topography of ocean bottoms. (Congress has been told that the Soviet ocean-surveying effort at the present time exceeds ours by at least threefold.)

• Reverberation.

• Exchange of energy at the ocean boundary.

• Transmission of light and elec-

tromagnetic radiation.

- Sound scatterers and absorbers.
- Surface wave motion.

From this listing it is seen that every phenomenon that influences the transmission of sound in water is being studied. This procedure indicates again the seriousness of the Navy in looking, not for breakthroughs in ASW detection work, but rather for progress in a reasonably planned program of technical studies.

Magnetic Anamoly Detectors (MAD gear), which depend on the submarine to change locally the earth's magnetic field, are detection devices carried by ASW aircraft. They have the advantage of being able to work aloft, unlike sonobuoys, but the disadvantage that their detection ranges are sharply limited. For efficient use, MAD equipment is flown not much more than 500 feet above the ocean's surface, and even then will give magnetic indications down only about 100 to 300 feet below the water's surface. How severe this limitation is becomes stark when we realize that the Navy *Trieste* went down nearly seven miles! Still, MAD is about the only way we can do search from aircraft, unless a submarine pokes above the water and gives radar a chance.

- **What is it?**—Classification, knowing what kind of a target we think we have, is a problem at least the equal of detection. Rear Admiral John S. Thatch, recently of Task Force Alpha, estimates that, "For every solid submarine contact, we are led astray on spurious contacts that may number from 10 to 100."

Even if the naval commander knew that enemy submarines were in the area, even then he could not promiscuously try to destroy every target he detected. The time and money wasted would be astronomical.

Data processing and correlating techniques, using as inputs the sonar characteristics of the target, is one way the classification problem can be worked. It is a slow way, though, and almost requires a cooperative enemy.

- **Where is it?**—Hand-in-hand with classification goes localization. The target must be pinpointed and tracked until something can be done about it. Aircraft if not going in for a kill can ring the suspected area with sonobuoys and at the same time call for surface ship help. Or the aircraft can try to keep contact with MAD gear. Helicopters can use their dunking sonobuoys, the sonar detection gear that is pulled through the water by the craft as though it were trolling for fish.

The coordinated effort of air, surface and underseas craft are needed to find hostile targets and destroy them. One such effort is Task Group Alpha, a hunter-killer armada comprising 10 ships and about 50 aircraft. Specifically, it contains an aircraft carrier, 4 aircraft squadrons, 7 destroyers and 2 antisubmarine submarines. Its peacetime mission is to develop ASW tactics, doctrine, and equipment in order to give maximum ASW readiness to the Atlantic Fleet.

WEAPONS NEEDED

Alpha's big kill weapon is *Betty*, an airborne atomic depth charge. Usable only if political conditions permit, *Betty* has a kill radius of several miles. Less lethal than *Betty* and presently operational are Westinghouse's *Mark 37* and General Electric's *Mark 44* acoustic homing torpedoes. These can be launched from aircraft or ship, are supposed to discriminate between decoys and real targets, and pursue their targets by radiating out in a spiral pattern.

A proud destroyer weapon are Hedgehogs (multiple ahead-thrown bombs), which are similar to mortars and have a range of between 250 and 300 yards. The beauty in their use is that a bomb pattern can be laid out in one shot, thereby fencing in the presumed target. Also, the strategem of an enemy submarine escaping down the attacking ship's wake cannot be used.

Two important missiles expected to be Fleet operational by 1961 are Goodyear's *SUBROC* and Minneapolis-Honeywell's *ASROC*. Both can use nuclear or conventional warheads. *SUBROC* will be the first weapon effective against nuclear submarines. It was designed as an underwater-to-surface-to-underwater missile but it can be used for surface-to-underwater work. As with all naval type missiles, it is solid-fueled. It has a 25- to 50-mile range in the air. Thiokol is handling the propulsion, Kearfott the guidance, and the Naval Ordnance Lab the weapon's development.

ASROC is a rocket-assisted torpedo and depth bomb. It is an expensive weapon, $1.2-million per installation. It is said that whenever an *ASROC* is launched, it is like throwing away a color television set.

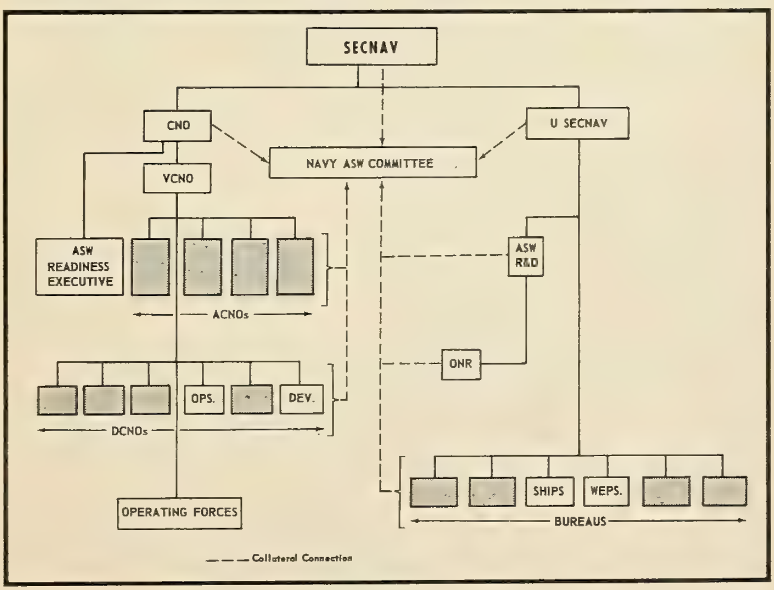
If we have these weapons then we must assume that a potential enemy does. This means that when moving in for the kill, one finds it safer to keep surface ships out of the way and let aircraft have the kill. If this does not work, then destroyers with Hedgehogs will have to be sent in or *Weapon Alpha*, a 500-pound rocket-propelled depth charge, or the antisub subs.

CARRIER REQUIREMENTS

The carrier-based Grumman S2F Tracker is the aircraft workhorse in ASW. In this vehicle is a complete package of radar, electronic countermeasure equipment, MAD gear, sonobuoys, and conventional electronics communication equipment.

The larger counterpart of the S2F is the Lockheed P2V Neptune, a land-based craft. It carries essentially the same equipment as the Tracker but more powerful types and more of them. Admiral Thatch says that like the S2F, "the P2V needs automatic navigation and control systems to make it truly all-weather and to keep track of the forces deployed over the wide area

How Navy's Organized for ASW



it can control." He goes on to say that the craft's "APS 20 radar is far superior to the S2F's, but is still so frustrated in its search for the elusive periscope that any appreciable wave height gives the peeking submarine an easy immunity."

The Douglas AD-5W, the Guppy, is essentially an elevated antenna for Task Group Alpha. It is used as an automatic relay for radar and communications over the vast search area. Another Alpha craft is the Sikorsky HSS-1 helicopter. It has the highly desirable automatic all-weather capability, and a sonar transducer that can do intensive exploring while the helicopter proceeds at low or zero forward speeds.

Introduced into the Fleet in 1961 will be a new all-weather search helicopter, the HSS-2, and a new improved carrier-based antisubmarine warfare aircraft, the S2F-3.

DASH, a drone ASW helicopter system, is also scheduled to become operational for the first time early in 1961.

USE FOR BLIMPS

Also useful in ASW work, but not with Task Group Alpha but rather for surveillance, are the non-rigid airships. Exemplary is Goodyear's 3PG-2W, a million cubic foot envelope used in coastal patrol. It cruises at about 50 knots. Goodyear is presently proposing its counterpart of a nuclear submarine, a huge nuclear-powered airship that could stay aloft for an indefinite length of time. Unhappily for airships, the Navy is not planning to buy any more of them for its ASW program.

• **What's lacking**—Where the Navy really needs help, according to Captain W. H. Groverman, Director ASW Weapons Systems Division, CNO, are in the following areas.

In instrumentation. What are needed are rugged operational instruments, not research ones, that will give continuous readings, while a ship is moving, of such things as temperature in the ocean, current distribution, density distribution and salinity. Today, the Navy has no practical device that will do any of these things. If the Navy did, it would permit them to do technical surveys of large areas of the ocean in a short time.

Until the Navy has a better knowledge of the water of the sea, it cannot effectively design equipment to solve its problems. For example, multipath transmissions of acoustic waves are difficult to predict because the values of the variables involved such as salinity and density are not known. If these were known, then techniques of signal processing and data processing might well enhance the chances of getting the kind of equipment needed for good ASW work.

In order to test the new families of ASW weapons, the Navy needs a fully instrumented deep-water test range. By deep water is meant 1000 fathoms. Such a range in makeshift form exists now in a location off the Atlantic seaboard. However, within the next five years, an operational matured facility is essential. This means that industry must develop instruments that will function with accuracy and reliability in very deep water. Typical needed components are highly compact long-life power units, untended sensing devices, and underwater propulsion devices.

For the range, data processing will be highlighted because of the complex medium in which ASW work is done. In addition, as testing goes deeper, problems associated with increased pressure become serious. Not only for the test range but also for the Navy, increased research is needed on metals, materials, seals, and propulsion against back pressure.

• **Touching all bases**—The future of ASW promises to take advantage of all the modern discoveries in compact electronics, high-energy fuels, and long-life secondary power units. If the Navy has any visions of setting up in the near future underground storehouses, underwater tugs, or underwater flotillas, they have not been revealed in unclassified circles.

In time of war, the Navy's job will be well done if the service's presence is sufficient to deter underwater craft. Also, in time of war, the Navy will not be spending too much of its energy searching the seas for hostile submarines. Rather, the service will be closing in on the ports from whence underseas craft will be issuing.

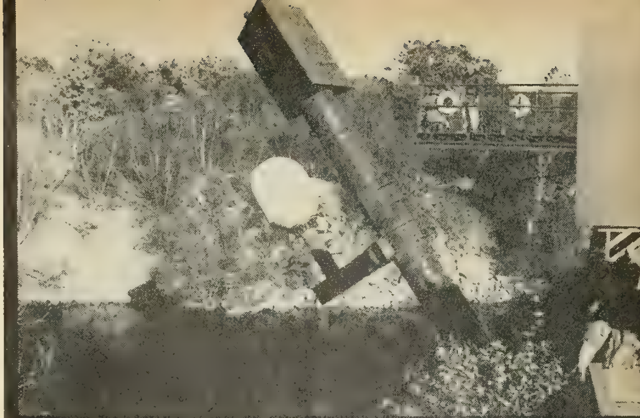
Portable Sonar

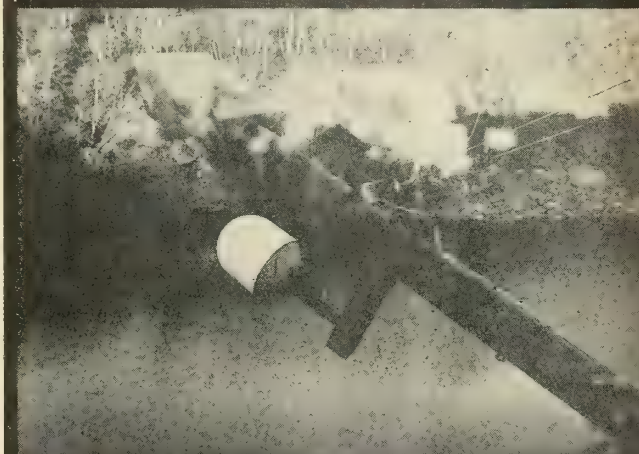
PORTABLE TRANSISTORIZED sonar system, powered by flashlight batteries, has been designed for use by Navy divers and frogmen. The AN/POS-1 equipment, developed by Stromberg-Carlson and the Navy Electronics Laboratory, has an effective range of 300 yards. Earphones provide the user with audio information on objects detected by the searching sonar beam. System weighs 20 pounds and is slightly larger than a basketball. Ten prototypes will be delivered under a BuShips contract.

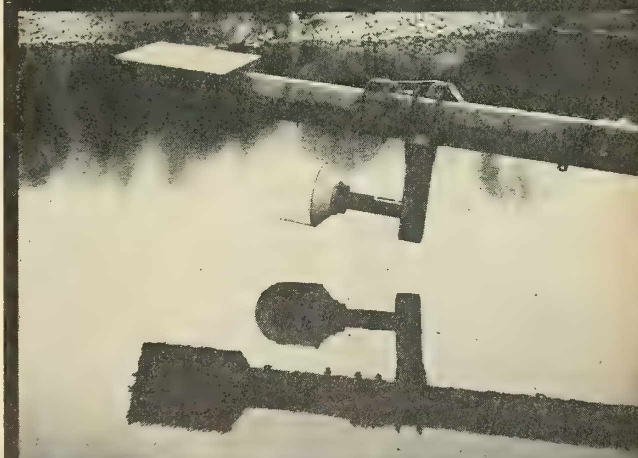
Underwater Engineering Conference Scheduled

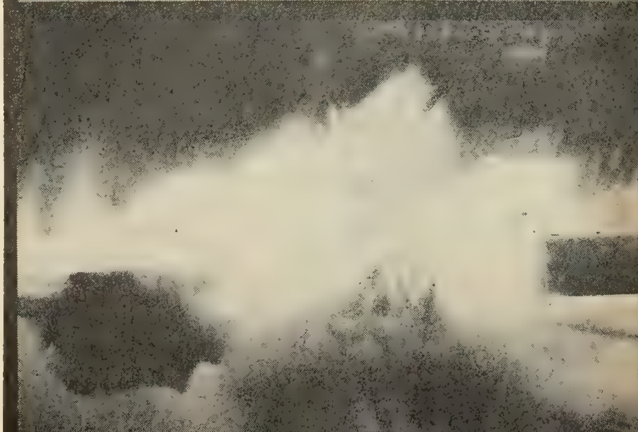
A classified seminar on underwater missile engineering has been scheduled for July 10-22 at Pennsylvania State University. Discussions will center on underwater missile design problems in acoustics, electronics, flow noise, noise reduction, control, hydrodynamics, and propulsion. Attendance is limited and subject to Navy Department security approval.

Lectures and discussions will be augmented by demonstrations and tours of the University's Ordnance Research Laboratories including the Garfield Thomas Water Tunnel and Black Moshannon Calibration Station.









for better navigation . . .

Polaris Sub Radome Battered in Testing

The ability of the *Polaris* submarine radome to survive the smashing impact of high seas is being tested in a unique series of experiments at an abandoned granite quarry near Boston. Conducted by Nortronic Precision Products Department for the Navy's Special Projects Office, the development is aimed at improving foul weather navigation for *Polaris* submarines through radio astronomy.

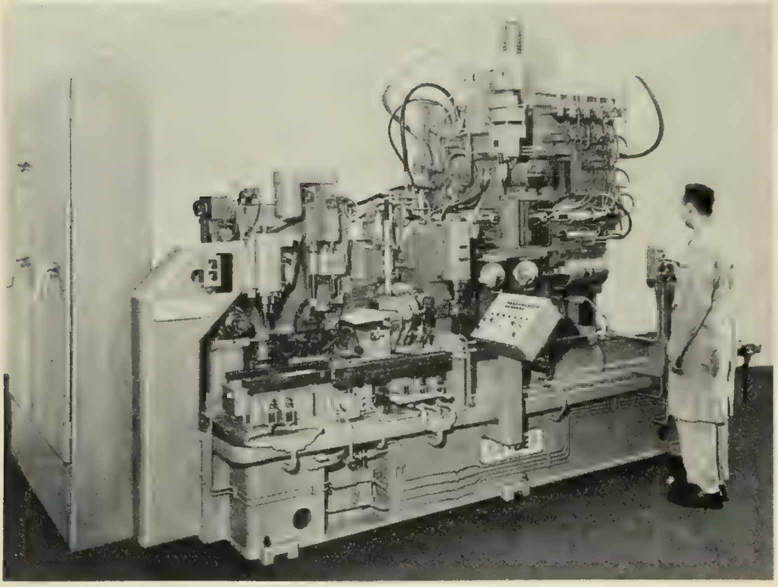
For the tests, the radome is mounted on a 40-ft. steel boom hinged to the vertical face of the quarry. The boom is then released and the radome smashed into the water.

The top photograph shows the boom being lowered into position above the water for a test drop. Next the boom is poised for release from a calculated height. The center photo catches the dome in flight just before it hits the water. After the impact, a two-man team boards the boom to inspect the radome and secure the cables for another test.

The new radome was built to house the antenna for a radiometric sextant that lets the *Polaris* sub see through bad weather and shoot the sun by zeroing in on the radio signals continuously emitted by the sun, or by signals from the moon.

On the submarine, the radome protects the antenna dish mounted on top of a stainless steel mast. An automatic system to direct the antenna is located below decks.

Such a radio telescope for submarine use represents a milestone in navigation systems. The system requires astronomical accuracies in the drive and control systems and yet must meet the rugged environmental conditions encountered underseas.



Tool Designed for Aluminum Alloys

A programed tool that performs a wide variety of milling, drilling and tapping operations on cast aluminum alloy missile wings at a rate of 17 pieces per hour at 100% efficiency has been designed and built by Snyder Corporation.

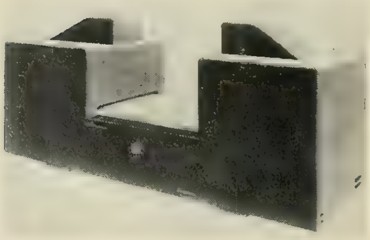
Basically the unit is a line-index type in which the missile wing is clamped in a fixture and traversed on hardened and ground ways to various machining positions. In completing the machining of the part, the work fixture is moved by a hydraulic cylinder arrangement along a 68-in. long path.

The tool has a welded steel base to which are bolted welded bases, arms and columns for several different types of moving and fixed machining units. The fixture is located by shot pins for machining operations in intermediate positions and by stops at each end of the travel. Some machining operations are carried out while the fixture is being indexed from one fixed position to the next.

Eleven different machining operations are performed at five fixture positions on the missile wing by an assortment of machining units including a Snyder standard way-type unit, two air-powered motorized drilling units, two motorized three-spindle drill heads, a two-spindle motorized tapping unit, nine motorized precision spindles, four air-powered, air-fed single-spindle drilling units and three air-powered, air-fed lead screw single-spindle tapping units.

The Snyder special missile wing Programed Tool occupies a floor space approximately 176-in. by 120-inches. It is about 132-in. high. Hydraulic power for indexing and slide operation is provided by a separate motorized hydraulic pump and tank unit. Electrical controls are in a panel at the side of the machine.

Circle No. 225 on Subscriber Service Card.



Vibration Test Table

A new type of electromechanical vibration table for the environmental testing field is being introduced by Westinghouse Electric Corp. Conceived as a single unit or "package," the "Duopower" will be the first of a complete line of vibration test equipment to incorporate a slip plate or table between two shaker heads and thus eliminate power loss of present systems due to the coupling equipment.

The shaker table also has been designed to vibrate in a horizontal plane as its prime function—a radical departure from present tables—because company engineers found a majority of test requirements called for this type of testing. It is possible to test in a vertical plane merely by using a "knee" mounted to the table.

The table will develop 3000 pounds of force for testing the reliability of rocket, missile and aircraft components and their ability to withstand extreme vibration of actual blast-off and flight.

The Duopower testing equipment, through operation of the two shaker heads in a push-pull manner, will offer a more equally-distributed first vibration as well as a truer picture of complex motion. Through elimination of many of the expensive test fixtures, the table will permit greater working area and now make it possible to mount and test larger components than before.

At the same time, the magnesium slip table has been built to afford the user a much lower work area to avoid motion loss and provide more rigid and useful vibration testing of the machine.

Weighing 5000 pounds, the vibration table is 33½ in. high, 78 in. long and 29 in. wide with the power supplied from a Westinghouse audiopower amplifier designed specifically for vibration testing. It is enclosed by an aluminum cover except for the working table area and includes dust-proof jackets on the shaker heads.

Circle No. 226 on Subscriber Service Card.

Moulding Compound

A moulding compound offering advantages in the production of components that must withstand tremendous heat and pressure has been produced by Johns-Manville.

Offering maximum resistance to flame erosion in high-temperature service, "Thermomat" is composed of a non-woven asbestos felt saturated with a thermosetting phenolic resin and an inorganic filler, and is furnished in sheet form for easy one-piece lay-up.

As supplied for fabrication, the partially-dried slabs of Thermomat are extremely conformable and allow convenient one-man lay-ups. Random fiber dispersion provides maximum reinforcement to the cured Thermomat, yet allows easy working together of joints and seams and free flow of material during the moulding operation.

Flexible before curing, tough and

rigid after cured, Johns-Manville Thermomat is extremely resistant to high temperatures and offers exceptional resistance to physical abrasion and erosion during the ablation process. In a typical missile application, Thermomat, fabricated in a ⅛-inch thickness, protected the metal casing of a solid fuel compression chamber operating at

5000° F for approximately 90 seconds, in an area with no flame erosion. Typical physical properties of Thermomat Style 179, cured as directed, indicate a density of 106 pounds/cubic foot, shear strength of 20,300 psi, tensile strength 15,474 psi, and an ultimate flexural strength of 25,300 psi.

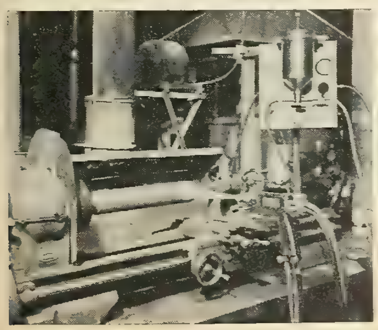
Thermomat is available in a variety of styles, with varying resin, asbestos fiber, and additive contents to allow fabrication of components with the final properties desired for specific application. Thermomat is available in slabs 14-inches wide, approximately 12-feet long, and $\frac{3}{16}$-inch thick.

Circle No. 227 on Subscriber Service Card.

Spraywelder Unit

A lightweight, compact Spraywelder Unit which features a high spray rate (over 12 lb/hr) and exceptional deposit efficiency (up to 95%) is now available from Wall Colmonoy Corporation. The new equipment provides 20% reduction in spray pistol weight.

Major physical improvement in the redesign of the Spraywelder pistol is



simplification of controls. Former trigger and powder flow control have been combined into one simple positive-acting operating valve. Elimination of the trigger mechanism substantially reduces the space requirement, permitting a more compact pistol design and leading to a principal advantage of reduction in weight.

The pistol is 20% lighter than the former Model C-2 design. The smaller, lighter unit is easier to manipulate and less fatiguing to handle, factors of particular importance in manual spraying applications. The new pistol design utilizes the established Colmonoy principle of using air for powder feed. This arrangement permits full efficiency operation in any position through 360° in vertical or horizontal planes and insures non-porous powder deposits.

A simpler tip alignment procedure makes tip changing easier in the new pistol design. A pistol holder (optional) is available for mounting the Model D pistol in the lathe tool post. This device makes possible use of the lathe's traverse mechanism to achieve uniform, rapid build-up when spraying cylindrical parts. The holder design includes a positive lock-up mechanism which insures positive mounting.

The hopper portion of the new Spraywelder Unit has been enlarged in keeping with the increased spray rate capacity of the Model D pistol. It has a powder-storing capacity of 15 lb.; enough for 1 to 1½ hours of steady spraying. The hopper is provided with a new sight-gauge powder level indicator.

The Model D unit has been provided with a more efficient air filter and regulator. Double-action moisture separation is accomplished through utilization of a sintered metal moisture removal cartridge as well as a centrifugal drying mechanism.

Except for the elimination of the trigger, there is no difference in operation of the new Model D unit as compared with former designs. The same Sprayweld Process techniques and procedures apply.

Circle No. 228 on Subscriber Service Card.

High-Speed Printing Bulb

A cathode ray bulb with 35,000 separate wire conductors embedded in a face plate only 3 by ¼ inches in size has been developed for high-speed electronic printing by the Corning Glass Works.

The new process is capable of printing 20,000 characters a second. It also can be used to transmit by microwave or wire systems facsimiles of graphic and printed materials—documents, records, maps—even mail.

Corning produces the vacuum-tight bulb with wire-embedded face plate for use in the Videograph process devel-

oped by the A. B. Dick Company. Bulb design was a cooperative effort by Corning and Sylvania Electric Products, Inc. Sylvania processes the finished tube.

Each conductor in the rectangular matrix of the fact plate is .001 of an inch in diameter—half the thickness of a strand of human hair. Nominal space between conductors is .003 of an inch.

These conductors serve to transfer an electrostatic charge from an electron

beam to moving paper. The information can be obtained from a computer or from magnet tape. The videograph, according to the A. B. Dick Company, prints the information as fast as it can be fed to the equipment.

Circle No. 229 on Subscriber Service Card.

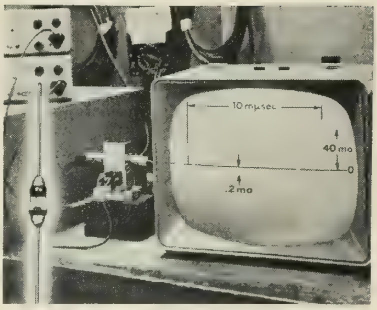
Ultra-Fast Diode Developed

A silicon switching diode now available has a maximum operating time of 8×10^{-10} second and is believed capable of performing 5×10^{8} logic functions in less than one second.

Developed by Sylvania Electric Products, Inc., the new diode is designed for use in high speed military computers, such as missile guidance and tracking systems, and in commercial equipment.

The device has a typical rating of 0.3 millimicrosecond. Switching time of the fastest diode previously available was approximately 3 to 4 millimicroseconds.

As other components of comparable speed are developed, it will be



possible, for the first time, for logic circuits to process ideas in a few billionths of a second, according to Sylvania.

Designated type D-4121, the new diode is hermetically sealed and capable of operation at 150° C. It offers superior performance despite extreme conditions of vibration, shock, temperature change and moisture, said the company. It is also capable of operation in the microwave range (1000 mc and upward).

Circle No. 230 on Subscriber Service Card.

New Literature

MOLYBDENUM SPECIFICATIONS—The Refractomet Division of Universal-Cyclops Steel Corp. has published a molybdenum mill products specifications booklet. The booklet covers unalloyed molybdenum and Mo-0.5 Ti alloy billets, bars, plates and sheets. Material specifications for each of these standard mill products include: scope, manufacture, chemical composition, structure, mechanical properties, dimensions, finish and inspection.

Circle No. 200 on Subscriber Service Card.

RELAYS. Diaphlex Division, Cook Electric Company, announces the release of a new Relay Manual featuring 30 types of relays, (with 1,000 variations), for communications, computers, industry, and the military. Using photographs, line drawings, tables and descriptive material, the publication presents detailed data on the many established pile-up relay types, variations in spring arrangement, timing, coil voltage, contact ratings and other useful classifications are outlined.

Circle No. 201 on Subscriber Service Card.

ALUMINUM MANUAL. The Aluminum Association has published a 392 page Aluminum Construction Manual ($3) providing in a single volume data essential to designers, engineers and architects concerned with stressed aluminum structures. The book presents for the first time computations of allowable loads for beams and columns of aluminum alloy 6061-T6, one of the most widely used aluminum structure alloys.

Circle No. 202 on Subscriber Service Card.

SEALLESS PUMPS. Sealless leakproof pumps are described in new four-page, two-color Chempump Bulletin 1030-2 available free from Chempump Division, Fostoria Corp.

Circle No. 203 on Subscriber Service Card.

BALLOONS. A new 16-page brochure titled "General Mills Balloons" is an up-to-date summary of the company's plastic balloon capabilities for upper air research. It describes and illustrates conventional-type, free floating polyethylene balloons, captive Aerocaps, antenna-supporting kite balloons, Mylar spherical satellite balloons, plastic missile shelters, and other developments. The two-color brochure also describes and pictures some of the special equipment and special balloon services available at General Mills.

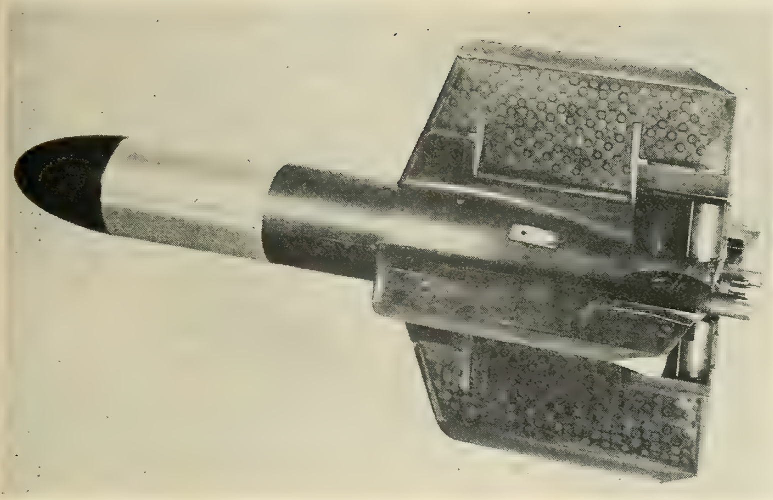
Circle No. 204 on Subscriber Service Card.

PRINTED CIRCUITS. A new two-color bulletin on Printed Circuits has been issued recently by Whitney Blake Co. The folder discusses the benefits accruing from the use of printed circuits and provides a list of information needed by the manufacturer when quotations are to be made. In addition, the types of insulating materials and the current capacity in relation to width of copper conductive pattern are described. The folder also lists the choice of metals available for the conductive pattern as well as the types of plating recommended to achieve desired results. Recommendations covering materials available for switch and contact patterns are also included as is a list of the company's facilities and a partial list of companies served.

Circle No. 205 on Subscriber Service Card.

CHECK VALVES—A comprehensive new brochure on multi-flapper check valves has been made available by Bobrick Aero Missile Products, division of Bobrick Manufacturing Corporation. Included in the new brochure are illustrations, specifications and technical descriptions of the new line of valves which cover duct valves, ground start inlet and check valves, and various types and sizes of insert valves. Designed for fuel and LOX handling as well as for air conditioning application, types of the new valves are currently in use by Boeing, Convair, Douglas, Lockheed, Martin, Republic and Norair.

Circle No. 206 on Subscriber Service Card.



One Man Can Fire *Bantam*

The wire-guided *Bantam* now being developed for Sweden by Aktiebolaget Bofors is primarily an antitank missile with an effective range of 1000 to 6500 ft. Weighing 19.8 lbs. overall in its carrying container, the *Bantam* can be operated by one man.

Recently disclosed specifications of the *Bantam* show it to be somewhat similar to the Nord wire-guided *SS-10* and *SS-11* antitank missiles. The *Bantam* has two solid-propellant motors, a booster and sustainer which accelerates it to a top speed of 190 mph.

Length of the missile is 2.5 ft. It has a body diameter of 3.9 in. and the cruciform wings have a span of 15.7 in. Firing weight is 13.2 lbs. and warhead weight (either armor-piercing or high explosive) is 3.1 lbs.

Corners of the wings are bent, making the missile rotate in its trajectory. Directional control is obtained by actuation of electrically-driven spoilers through a transistorized receiver. The control unit weighs 4.3 lbs.

Germans Arming in 3 Stages

A three-point program for equipping German Armed Forces with guided missiles and planes has been outlined by the Director of Air Technical Division, German Ministry of Defense.

Dr. Theodor Benecke said the plan's first stage, now concluded, involved rearmament with Allied equipment. The second stage, now going on, is Germany's gradual adoption of NATO armament systems, and finally, the third phase will be Germany's attempt to provide its own armament.

Benecke said the *Sidewinder* infrared guided missile program for the Luftwaffe's F-104 is an important aspect of allied cooperation. *Sidewinder* license production will be promoted jointly by Norway, Denmark, the Netherlands, Greece, Turkey and Germany. The bulk of the European orders will be placed with a specially founded subsidiary of Bodenseewerk, Perkin-Elmer GmbH at Uberlingen, Germany.

European *Hawk* production, Benecke said, will be a joint French, Italian, Belgian, Netherlands and German effort, with American assistance. A special NATO organization in Paris has been established for this program, and the French firm, SETEL (Societé Europééné de Téléguidage), figures as prime contractor.

Soviets Claim Van Allen Belt

A Soviet astrophysicist has advised his fellows that "Soviet scientists can claim priority in discovering the inner belt and have played an important role in studying the outer one."

Professor A. Lebedinskiy credits Prof. James Van Allen of the US with the discovery of the inner "belt," but he finds that it was not until measurements had been performed with *Sputnik III*—launched May 15, 1958—that it was possible to determine the boundaries of the inner zone and to evaluate the energies of the zone.

Lebedenskiy points out that the counters installed on the first and third US satellites did not significantly differ from those carried by *Sputnik II*. *(Pravda, Mar. 23, p. 6, cols. 1-2.)*

British Electronics Council Will Serve Growing Market

LONDON—United Kingdom electronic interests have formed an Electronic Industry Council much like the Electronic Industries Association in the United States to serve their £200 million market.

Led by the Electronic Engineering Association, the Radio and Electronic Component Manufacturers Federation and other bodies have joined in the formation of the new group.

The Council will be concerned with electronic instruments, sound and television transmitters, radio communication equipment, radar and radio navigational aids, computers, industrial electronic control equipment and industrial television and the electronic components used therein.

All associations or federations of manufacturers of electronics components apparatus or equipment are eligible for membership except those in the broadcast radio and television receiving industry and public telephone services.

The EIC will function much like its American counterpart in dealing with matters of concern to the whole industry, while its constituent bodies remain autonomous in their own fields of activity.

Firm Will Help Small Companies Sell Overseas

A firm to handle international technological licensing and help smaller firms form joint ventures abroad has been formed under the name Ladd & Little, Inc.

Foreign patent owners will also be represented by Ladd & Little for sales in this country. It has already received commissions for several French patents.

Montague V. Little, George T. Ladd and several other former executives of the Al Fin Division of the Fairchild Engine & Airplane Corp. lead the firm. It will be located in Huntington Station, L.I., New York.

mergers and expansions

(continued from page 18)

SPERRY BREAKS GROUND: Construction began on Sperry Semiconductor's new headquarters in Norwalk, Conn. The new plant will be completed in September as part of a multimillion-dollar expansion program.

ALLEGHENY LUDLUM PLANS: A $40,000,000 program of expansion and modernization of Allegheny Ludlum Steel Corp.'s plant facilities is underway at principal locations of the firm's operations.

KEY POLYMER FORMED: Jacob Lichman, Sydney Comins and Adrian Comins have formed Key Polymer Corp. in Lawrence Mass. It will specialize in adhesives and coatings from epoxy and polyurethane polymers.

NEW COMPUTER CORP: Embree Electronics Corp. will enter the computer field with a line of related products in the field of electronic analog computers. R&D is being performed by the University of Virginia.

DEUTSCH PLANS BUILDING: The Electronics Components Division will be increased by 40% by a new building to be completed late this summer.

GENERAL DEVICES ON WEST COAST—A West Coast field engineering, service and sales office has been opened in Los Angeles by General Devices, Inc. The new operation will serve Western States and Rocky Mountain area.

SYLVANIA PLANS NEW LAB: Sylvania Electronics Systems, division of Sylvania Electric Products, Inc., plans an Applied Research Laboratory facility and headquarters building—45,000 sq. ft. of new construction each—on a 55-acre site adjacent to present facilities in Waltham.

GERMAN BRANCH EXPANDS: Consolidated Electrodynamics Corp., a Bell & Howell subsidiary, has expanded its wholly owned subsidiary in Germany, Consolidated Electrodynamics Corp., Gmbh. The German corporate headquarters has moved to larger quarters in Frankfurt and branch offices have been opened in Hannover and Paris. Assembly of some CEC products by the German operation will begin in July.

NEW HUGHES DIVISIONS: Hughes Aircraft Co. has established two new divisions for development, production and marketing of commercial vacuum tube devices. New groups will be known as Microwave Tube Div. and Vacuum Tube Products Div.

ATLEE BURGEONS: Atlee Corp. has acquired and merged with Industrial Electronics Co., Inc. and Applied Dynamics Corp., and will operate under the Atlee name.

S-F-D LABS GROW: The Varian Associates' subsidiary is increasing its facilities by about 2/3.

financial

• **Lockheed MSVD**—The division has disclosed that its sales objectives for 1960 are $42 million, and $61 million in 1961.

• **Lear, Inc.**—A net income of $2.4 million for the year ending Dec. 31, 1959, is reported, comparing to $1.6 million for 1958. Shipments rose 37% over the previous year, totaling $87 million. New business climbed to a record $100 million, and the division has a backlog of $63 million.

• **Marquardt Corp.**—Highest sales in the company's history were realized at $69 million, 39% over the previous year. Earnings amounted to $1.3 million, 15% over 1958's $1.1 million.

• **General Dynamics Corp.**—Last year G-D became the nation's leading defense contractor, and had record sales of $1.9 billion in 1959, compared with $1.6 billion the year before. Earnings dropped somewhat, however, mainly because of cost of developing the Convair 880 and 600 air transports and building new facilities, according to the company.

• **Lockheed Aircraft Corp.**—Although sales exceeded the $1 billion mark for the first time last year, Lockheed earnings fell from $18.8 million to $8.7 million. The company said the principal factor was the excess of costs over selling prices of commercial aircraft.

• **Vitro Corp. of America**—Income before special charges amounted to $565,000. Special charges of $1.4 million were made against income, resulting in a net loss of $911,000 in 1959 compared with 1958's net loss of almost $1.5 million.

• **U.S. Industries**—U.S.I. sustained a loss of over $1.7 million for 1959, which the company attributes to retarded machine tool buying and to the prolonged steel strike. Sales totalled $86.6 million, compared to $86.4 million in 1958, in which year profit was $672,000.

• **Chance Vought Aircraft, Inc.**—In a year of several large contract cancellations by the Navy, including *Regulus I*, Chance Vought suffered a drop in sales from 1958 of almost $80 million. Total sales for 1959 were $254.6 million, as opposed to the previous year high of $333.1 million. Net income fell almost to half, $4.9 million of 1958's $8.9 million. Backlog at end of 1959 amounted to $253 million, also considerably under 1958's year-end orders of $370 million.

• **Allegheny Ludlum Steel**—Sales and revenues increased, $232.6 million compared to 1958's $202.6 million. Net earnings doubled, $11.3 million to $5.9 million.

• **Textron Electronics, Inc.**—Net sales for twelve months ending Jan. 2 totalled $308.2 million, compared with '58 total of $244.2 million. Net income also showed a nice increase with $16.6 million to $10.7 million in the previous year.

• **The Sanborn Co.**—Net sales were $15.0 million, and earnings $.6 million. 1958 totals were $12.9 million and $.5 million earnings.

—contracts—

NAVY

$4,895,000—General Electric Co.'s Light Military Electronics Dept., Utica, N.Y., for continued production of the *Sidewinder* air-to-air missile.

MISCELLANEOUS

Lear, Inc.'s Industrial Products Group, Santa Monica, received a contract to produce ten remotely operated automatic control systems for nuclear reactors being developed by **Martin's Nuclear Division**, Baltimore. Amount not disclosed.

Blaw-Knox Co., Pittsburgh, Pa., received a "several-million-dollar" contract to design and fabricate a 120-foot tropospheric scatter communication antenna for expansion of the northern defense radar system. Subcontract from **Western Electric Co., New York City.**

AIR FORCE

$3,500,000—General Electric Co., for five high-powered long-range air defense radar sets.

$537,629—Eitel McCullough, Inc., San Carlos, Calif., for electron tubes.

$87,063—Thiokol Chemical Corp., Elkton, Md., for rocket motors to be used in support of Project *WS-133A*.

$74,215—The Martin Co., Rias Div., Baltimore, for determination of the characteristics of cosmic radiation in the vicinity of the earth.

$47,276—Bomac Laboratories, Inc., Beverly, Mass., for electron tubes.

ARMY

$12,499,147—Raytheon Co., Andover, Mass., for 22 battery sets for *Hawk* ground support system.

$5,500,000—Convair Div., General Dynamics Corp., Pomona, Calif., for development of a new air defense missile to be known as *Mauler*.

$2,016,250—Western Electric Co., Inc., New York City, for 165 sets of digital data terminal equipment for use with the missile monitor system.

$1,962,900—Western Electric Co., New York City, for *Nike-Zeus* communications and instrumentation facilities for testing the weapon on Kwajalein Island.

$1,630,624—U.S. Steel Corp., Consolidated Western Steel Div., Los Angeles, for rocket motors and containers.

$1,594,000—Chrysler Corp., Detroit, for design and development of hypersonic ballistic target missile system.

$1,564,970—Kurz & Root Co., Appleton, Wis., for 2,131 generators.

$1,300,000—Sperry Rand Corp., Great Neck, L.I., N.Y., for modification of an existing contract for work on Doppler navigation equipment.

$1,145,402—Thomas Bate & Sons, Inc., Denver, for construction of a guided missile and technical supply building at Lowry AFB.

$1,120,000—Chrysler Corp., Detroit, for the *Jupiter* missile system.

$1,119,941—Boeing Airplane Co., Wichita, for overhead door hinge assemblies for *Atlas* missile launch complexes.

$1,040,000—Stanford Research Institute, Menlo Park, Calif., for continuation of study of air defense systems.

$760,000—Chrysler Corp., Detroit, for *Redstone* missile system repair parts.

$720,316—Raytheon Co., Waltham, Mass., for concurrent repair parts for *Hawk* missile system.

$697,883—The Martin Co., Orlando, for *Lacrosse* research and development.

$405,691—Douglas Aircraft Co., Santa Monica, for *Nike* replenishment spare parts. (Six contracts.)

$344,800—Todd Ship Yards Corp., Houston, for construction of a 180-ft. barge to transport *Saturn* space rocket booster from Huntsville to the launch site at Cape Canaveral.

$325,437—Radioplane Co., Van Nuys, Calif., for flight services for the *RP-76* target missile.

Edward J. Horkey: Named vice president-engineering at Houston Fearless Corp. Will also remain president and chief executive officer of the firm's subsidiary, Horkey-Moore Associates. Prior to joining the firm in 1953, was vice president of Pastushin Aviation Corp. and prior to that chief technical engineer at North American Aviation, Inc.


HORKEY

Charles Jackson: Formerly of Minneapolis-Honeywell Co., joins Monitor Products Co. as chief engineer and **Charles Manson** of Bendix Corp. named purchasing agent.

Ralph I. Cole: Manager of military project planning, engineering services at Melpar, Inc., appointed to the committee on Missile Support Equipment of the Advisory Council on Federal Reports.

Arthur S. Pawling: Formerly assistant factory manager, named factory manager, and **E. R. Harrall,** former manufacturing manager named director of product quality and reliability, at Friez Instrument division of Bendix Aviation Corp.

Andrew Ireland: Appointed infrared systems consultant for the Electronics Systems Engineering Dept. of Servo Corporation of America. Previous posts: Crosley Div. of Avco, Convair, U.S. Army Engineering Research and Development Laboratories.

Justin L. Bloom: Former chief of the materials management branch of the U.S. Atomic Energy Commission, San Francisco Operations office, named project engineer for advanced SNAP programs in the Nuclear Division of The Martin Co.


BLOOM

Robert W. Cuthill: Former assistant and advisor to Maj. Gen. John B. Medaris, ABMA, named chief engineer of The Martin Co.'s Orlando Division.

Varian Associates names three vice presidents: **Paul B. Hunter,** Patent Dept.; **Dr. Theodore Moreno,** Tube Division; **Dr. Emery H. Rogers,** Instrument Division.

Joseph Rae Conway, Jr.: Former senior engineer in charge of gyro design and development with Eclipse-Pioneer division of Bendix Aviation Corp., appointed director of marketing at Whittaker Gyro division of Telecomputing Corp.

J. P. Henry: Vice president and general sales manager, elected a director, and **Henry C. Fechtmeyer** named vice president, at Ampco Metal, Inc.

Charles E. Baugh: Appointed manager of Garrett Corp.'s Atlanta sales office, replacing **Ray Gambon,** now in the Los Angeles office.

Hughes Aircraft Co. appoints three to directorships in the recently formed Advanced Projects Laboratories: **Dr. Fred P. Adler,** former manager of advanced planning in the Systems Development Laboratories, named director; **Dr. Leonard Gross,** assistant manager of systems and analysis named assistant director, and **Dr. Renne S. Julian,** technical director of the guided missile laboratory, named technical director.

Thomas N. Kasabali: Elected manager of military relations, Customer Relations Dept. at Summers Gyroscope Co. Prior to joining the firm in 1958 was a design engineer at Douglas Aircraft Co.

Robert M. Wood: Former plant manager, Semiconductor Division of Sylvania Electric Products, joins Pacific Semiconductors, Inc. as manager of the transistor plant, and **David M. Edwards** selected as manager of Manufacturing Planning and Control.

F. H. Gerhard: Former senior research engineer at Autonetics Division of North American Aviation, joins Espco-West as senior design specialist responsible for all analog circuit design. He developed the amplifiers in the autonavigator that guided the Nautilus under the North Pole, and is the holder of nine patents.


GERHARD

P. G. Smith: Appointed executive vice president, and **Donald E. Butler,** vice president-sales, for the Royal Jet Division of Royal Industries, Inc.

John A. Swint: Former president of Vard, Inc., appointed director of The Marquardt Corp.'s Utah division.

Norman J. Golden: Named vice president-research and development for Hoffman Electronics Corp.'s Semiconductor Division, succeeding **Dr. Morton B. Prince,** now division vice president-general manager.

Dr. Richard W. Eppley: Joins the Astro Systems and Research Laboratories of Northrop's Norair Division to participate in development of foods for space travelers.

Robert E. Lorenzini: Joins the technical staff of Rheem Semiconductor Corp. and will be concerned with development of new crystal growing techniques for semiconductor materials.

Harold P. Field: Former director of marketing of Stromberg-Carlson's Electronics Division, joins System Development Corp. as director of plans and programs.

W. Van Alan Clark, Jr.: President of The Sippican Corp., simultaneously elected to the board of the Electronic Engineering Co. of California and The Sippican Corp. He is also a director of Avon Products, Inc. and Tibbetts Industries, Inc.


VAN ALAN CLARK

W. G. Lohmeyer: Formerly senior project engineer with the Defense Products Division of Fairchild Camera and Instrument Corp., joins DeJur-Amsco Corp., as director of research and engineering.

Arthur L. Koehler: Appointed manufacturing manager of Sorensen & Co., subsidiary of Raytheon Co.

James A. Koch: Joins Precision Instrument Co. as senior applications engineer and **Mortimer Fleishhacker, Jr.** Assumes duties as assistant to the controller.

Charles E. Dolberg: Appointed director-systems management for Philco Corp.'s Government and Industrial Group, responsible for management of command and control systems, data transmission systems and integrated electronic data processing systems. Holder of eight patents dealing with electronic equipment.

Adolphe S. Kromer: elected president and general manager of Flexonics Corp., a subsidiary of Calumet & Hecla.

Wyman-Gordon Co. announced the appointment of three new vice presidents: **Joseph R. Carter,** general manager, Eastern Division; **James L. Roach,** director of marketing; and **Robert E. Zell,** general manager of the Ingalls-Shepard Division.

Henry Foster Dever: vice president of Minneapolis-Honeywell Regulator Co. in charge of its Industrial Products Group, has been elected a director of F. J. Stokes Corp., Philaldelphia.

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The Fight for Proprietary Rights

At this writing there are several bills before Congress relating to Small Business.

The fact that there is very little chance that any of them will be acted upon at this session should not prohibit American business from fighting some of the present evils largely affecting Small Business—evils which come not from laws but from directives issued by the Department of Defense.

Some months ago on this page (Oct. 26, 1959) we advised Small Business that any of the several bills pending before Congress could, instead of eliminating some government restrictions, actually make Small Business even more a captive of the government; that the Small Business Administration under the guise of protecting small industry was really intent on reducing it to its lowest level of competency.

And further—that it was up to responsible Small Business to fight for its independence and integrity.

At the moment a company which is neither small nor large—the Garrett Corporation of Los Angeles—is one of the leaders in a fight against Defense Department decrees which are striking at the heart of the American free enterprise system.

By congressional testimony and through other means, officials of the Garrett Corporation are calling attention particularly to the acquisition and use of contractors' drawings by DOD under the provisions of Armed Forces Procurement Regulation IX, Part 2, and MIL-D-70327, which defines Class 2 drawings.

Without going into highly involved details, we can roughly define Class 2 drawings as those executed by engineers for private industry, as opposed to those executed by engineers directly in the employ of the government.

And ASPR IX, Part 2, directs that prime or subcontractors must, when the article they make is made for military contract, turn over to the government a complete set of Class 2 drawings which will enable it to be reproduced elsewhere.

The drawings must include operational data which will provide information for instruction, operation, maintenance, evaluation or testing. They must have descriptive data or design drawings which will "permit manufacture by other competent firms."

The directive pays lip service to proprietary rights but defines them in such a way as to exclude even those things which our common law courts have repeatedly held up as being proprietary. It says, for instance, that if the Government can determine the manufacturer's know-how by a process of reverse engineering, then these drawings are non-proprietary; the government is free to use them to shop around among competitors for a lower price.

This degree of almost direct confiscation directly affects most of all the subcontractors, because the prime is protected by the very bigness of his product.

But the big prime can suffer also. He loses control of the performance of his products in the field, and runs the risk of having inadequately controlled parts contaminate inventory by the low-bidder route.

And the middle-size operator, too, can see his spare parts business ruined and the designs of his end items pass into the public domain without recompense to him.

As we said several months ago, it is up to responsible business of all sizes to carry this story and this fight to Congress. It is only the incompetent who wants to be captive, but the incompetent is frequently the most vocal. There is still time, but the campaign to restore and retain the rights and fruits of free enterprise must be organized and it must be strong.

Clarke Newlon

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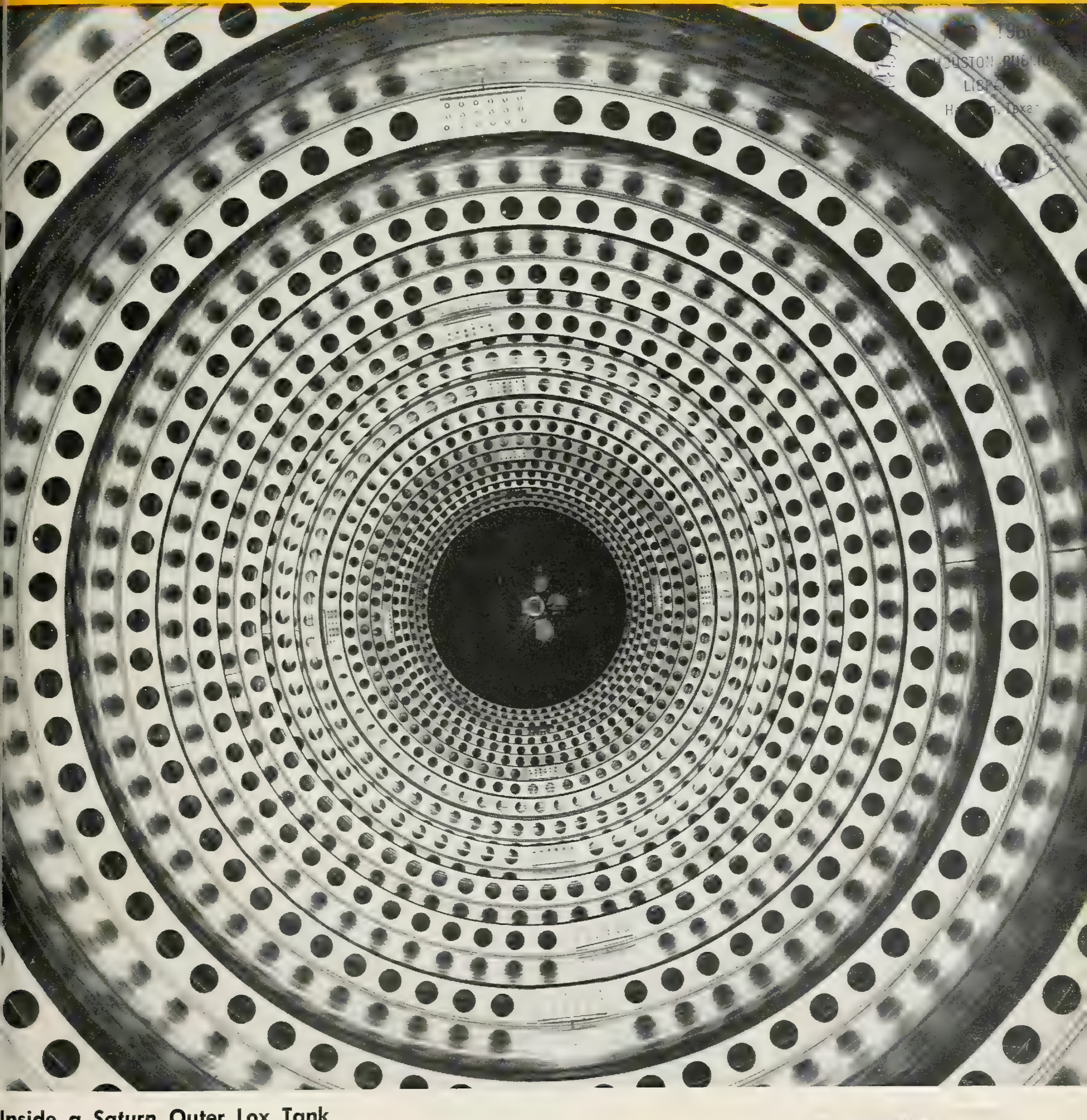
Circle No. 9 on Subscriber Service Card.

April 18, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



Inside a *Saturn* Outer Lox Tank

Another M/R Exclusive:

Saturn Fabrication . . . 16

AN AMERICAN AVIATION PUBLICATION

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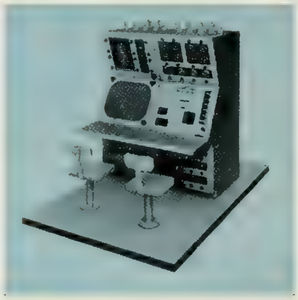
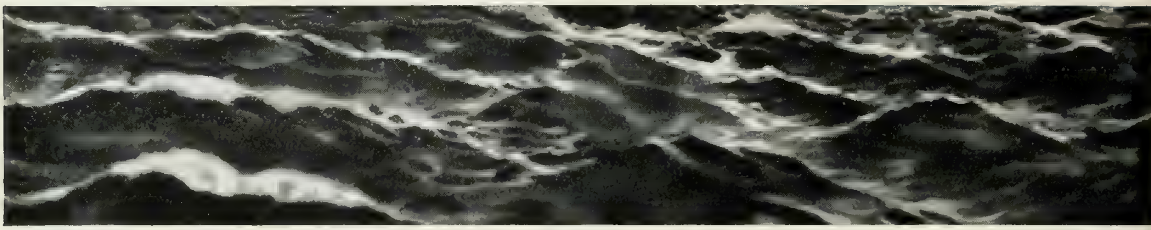
Since 1940, ships-of-the-line-and-train have mastered the sea's kinematics with a lengthening list of Librascope computers ■ Attack directors, torpedo and missile angle solvers, weapons control computers, attack plotters, depth plotters, position keepers, target motion analyzers, stabilization computers, roll and pitch computers. At sea as elsewhere, answers come fast and right from Librascope computers. For an eye-opening tour of the expanding boundaries of electronic calculation, in person or through literature, write Librascope, A Division of General Precision, Inc. ■ Librascope, 808 Western Ave., Glendale, Calif. ■ For career opportunities write G. Seltzer, Employment Mgr.





computers that pace man's expanding mind

GP LI-03

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THE MISSILE/SPACE WEEKLY

missiles and rockets

April 18, 1960 Volume 6 No. 16

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Fred S. Hunter
Vice Pres. and Editorial Director

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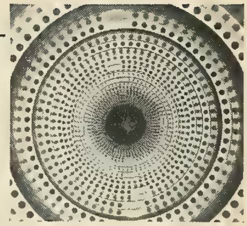
THE COVER



A partly assembled Saturn *outer LOX tank viewed from inside. Stiffening ringframes are spot welded into cylindrical sections before tank is welded. See exclusive story, p. 16.*

APRIL 18 HEADLINES

ASW ENGINEERING

ELECTRONICS

PROPULSION ENGINEERING

ADVANCED MATERIALS

INTERNATIONAL

PRODUCTS AND PROCESSES

DEPARTMENTS

31,400 copies this issue

letters

Astrolexicon?

To the Editor:

The missile and rocket field—being such a new, complex, and technical field—has spawned many new additions to the language. Exotic terms, highly technical phrases, and more highly abbreviated abbreviations of organizations, committees, etc., meet one's eye from about every other sentence of your fine publication.

Might I suggest as a special section to a forthcoming issue, a glossary of such terms and abbreviations, and that it be kept up to date in much the same manner as the Astrolog. Thank you for your consideration and for an outstanding magazine.

Robert W. Wempe, Ensign, USNR
NAMS
Little Creek, Norfolk, Va.

Real Patriots Lacking

To the Editor:

In your April 11 Letters, Ted Wallace's "The Gap—Another View" is certainly one of the most realistic and intelligent viewpoints on this subject I have heard, and it more and more proves the fact that those who are in a position to really do a job for "their country" and "mine" are still too much concerned with their own selfish personal gain. It's a terrible tragedy that today's generations have placed self far above country . . . Oh, for just a few real patriots in the right places.

M. L. Carlisle
Washington, D.C.

Sanity in Space

To the Editor:

I want to congratulate you on your editorial in the March 7 issue ("Let's Be Daring But Not Ridiculous"). I certainly think it is most appropriate.

I am reproducing the editorial in order to give a copy to each of our project engineers.

George W. Howard
Technical Director
U.S. Army Engineer Research and Development Laboratories
Fort Belvoir, Va.

Fuel Cell Best Seller

To the Editor:

Your cooperation is desired in correcting a situation growing out of information given in Letters section of the April 4 M/R.

It is regretted that the Army Research Office, Office of the Chief of Research and Development, Department of the Army, is unable to provide copies of ARO Scientific Report No. 1, "Status Report on Fuel Cells," as stated in the Editor's reply to an inquiry.

Initial distribution to official agencies concerned was made by the Army Research Office. Since that time, this office has not stocked copies to meet additional requests. The report *is* available to any institution, industrial organization or individual interested, upon written application to the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. The price is $1.25 and the order number is PB 151804. The report has enjoyed a record sale and is now in its fourth printing.

Robert W. Struder
Lieutenant Colonel, GS
Chief, Research Support Div.
Army Research Office
Washington, D.C.

Welcome for ASW Section

To the Editor:

I have been receiving your magazine for a month now, but wish it were a year. It is an excellent magazine, and I am looking forward to the AntiSubmarine Warfare Engineering Section.

There has been need for publications covering this field for some time. Congratulations on establishing this section; I am sure it will be representative of your other fine sections already established.

R. B. Wright
Dev. Engineer
Goodyear Aircraft Corp.
Akron, Ohio

To the Editor:

As a regular subscriber to M/R, I have read with great interest the treatment of ASW matters in your April 7 issue.

I consider that your treatment of the subject was outstanding, covering as it did the technical hurdles and the factual budget-submission breakdown which is the real key to the character and scope of the ASW effort.

I will be most interested to follow the output of your new department—and on the basis of the general excellence of your other reporting and analysis, I would expect it to be a very sound and helpful output.

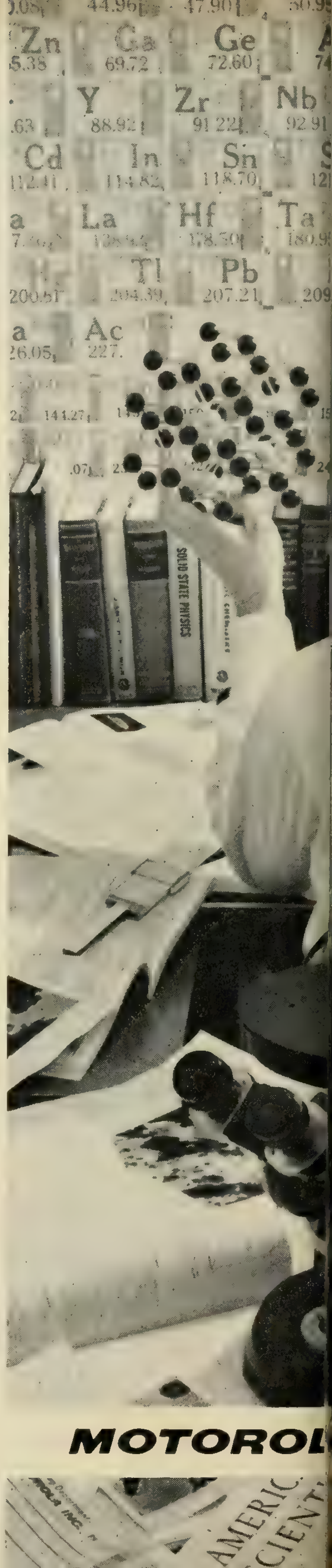
Robert B. Carney
Admiral, USN (Ret.)
Washington, D.C.

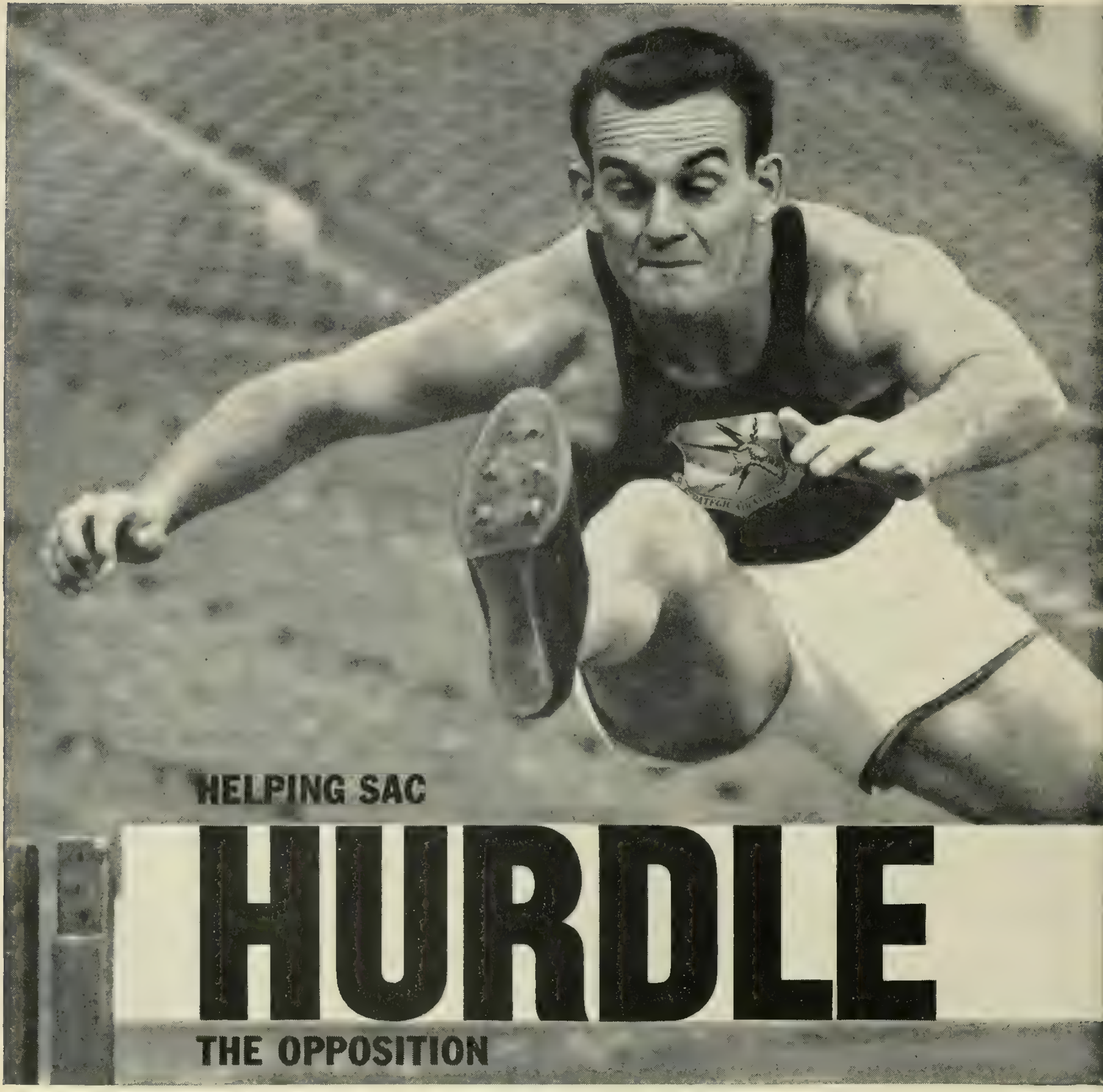
New Cover Pleases

To the Editor:

The new M/R cover is quite impressive. It is causing quite a lot of favorable comment.

David B. Juenke
Assistant to the President
Rocketdyne Division
North American Aviation, Inc.





SAC is now off and running with its new Hound Dog missile. With the supersonic GAM-77 missile, the B-52 bomber can more easily hurdle ground defenses on the way to a target. In the short span of just 30 months, the Hound Dog air-to-surface missile grew from the drawing board to a powerful member of SAC's deterrent team.

Silencing enemy ground defense centers while the mother ship speeds on toward the main target is just one of the jobs of the versatile GAM-77 missile. Slung beneath the swept-back wings of a B-52, a pair of GAM-77's can either clear a path for the bomber, or be sent right in on the main target itself. This triple-threat capability lets a single B-52 command a target approach corridor over a thousand miles wide.

To further confuse the enemy, these inertially-guided missiles can feint at pseudo-targets before turning toward their real objectives. Speed and altitude variations can also be programmed into the GAM-77's target approach.

The Hound Dog missile greatly extends the useful life and striking power of SAC's B-52 bombers—the backbone of America's strategic power. The GAM-77 is being produced by the Missile Division of North American Aviation.

MISSILE DIVISION

NORTH AMERICAN AVIATION, INC.
Downey, California

the missile week

Washington Countdown

IN THE PENTAGON

Warheads can be switched . . .

on the latest generation of *Sidewinders*. One warhead provides infrared guidance, the other radar. They are called Ira and Sarah.

• • •

Dyna-Soar tests . . .

during the next 13 months will include intensive work on materials and structural shapes. The Air Force is asking for $50 million in the new fiscal year for work on the *Dyna-Soar* glider and faster work on the *Dyna-Soar* booster.

• • •

Pint-size ICBM's . . .

are already considered feasible by top Pentagon officials. The ICBM would weigh between 20,000 and 25,000 pounds.

• • •

Some top ASW code names . . .

and the official programs behind them:

. . . *Atlantis*—A 1959 study aimed at determining the feasibility of developing a large ocean surveillance system.

. . . *Trident*—The Bureau of Ships exploratory R&D program aimed determining by experiment if the conclusions of the Atlantic study are valid.

. . . *Artemis*—R&D work on a deep-water, long-range, fixed antisubmarine detection system.

• • •

Julie and *Jezebel* . . .

are two of the Navy's new sonobuoys. *Julie* uses an explosive sound for echo ranging. *Jezebel* is a passive buoy.

• • •

A double life for BMEWS . . .

is envisaged by the Pentagon. Not only will it provide early warning of an ICBM attack, the big radar network also will be capable of detecting all polar orbiting enemy satellites.

• • •

Shopping suggestion . . .

for the missileman who has everything: A complete *Jupiter* missile is reported to be on a scrap heap at Redstone Arsenal waiting for a buyer. But no warhead.

AT NASA

NASA Chief Glennan may quit . . .

early in order to allow NASA Deputy Administrator Hugh Dryden to hold the top NASA post before the next Administration picks its own man. Dryden, a 40-year veteran of government service, is the former chief of the old NACA out of which NASA was organized.

• • •

More red tape . . .

is the description being pinned by many NASA officials on the new Aerospace Activities Control Board. They see the board as merely a sop to congressmen who opposed the elimination of the ineffectual Civilian-Military Liaison Committee.

• • •

Saturn production . . .

according to insiders, could be increased to 10 to 20 a year within the next four years. At present, NASA plans only to build 30 *Saturns* during the 1960's.

INTERNATIONAL

The French IRBM-ICBM . . .

program is undergoing a big speed-up as a result of the success of French A-bomb tests. The French are calling their ballistic missiles *SSBS's*—for Sol Sol Balistique Strategique.

• • •

Swedish *Falcons* . . .

will soon be pouring off the production line. The Swedish are making a deal with Hughes to produce the air-to-air missiles.

• • •

Security worries . . .

plagued NASA before they released the pictures of earth taken by *Tiros I*. NASA feared their pictures might be too good—thereby giving Russia an opportunity to make "spy in the sky" charges just before the Summit Meeting.

the missile week

Industry Countdown

MANUFACTURING

First *Titan* is being . . .

installed in the silo launcher at Vandenberg AFB. The bird won't be used as a flight vehicle—just as an R&D tool to check out launch instrumentation.

• • •

Look for *Pershing* . . .

production to begin this summer. Thiokol now has 120-day Army funding to complete development of continuous mix solid-fuel process at Longhorn Ordnance Works in Marshall, Tex. Propulsion unit production will be semi-automated.

• • •

Missile industry employment . . .

is now pegged at almost 400,000 by the Labor Department. The agency surveyed 482 plants and found the heaviest concentration of missile work in the Los Angeles-Long Beach area. Latest survey indicates a 60% rise in employment in the field in two years, which probably is misleading since the department previously had restricted its inquiry largely to the aircraft industry. The latest survey includes all missile producers listed by DOD as having more than 200 employes.

• • •

Payload vibrations . . .

transmitted from the solid-propellant X248 final stage are delaying the next *Atlas-Able* moon probe until August or later. The difficulty is forcing NASA into a complete redesign of the payload package structure.

• • •

Next big missile/aircraft . . .

producer to begin an aggressive diversification program will be McDonnell Aircraft. The corporation's stockholders will vote April 29 on increasing the authorized common stock from 2 million to 8 million shares. They are also expected to approve a change in the certificate of incorporation to permit the company to diversify.

PROPULSION

Martin has unofficial go-ahead . . .

to redesign the *Titan* to use Aerojet-General's storable liquid (N_2O_4-N_2H_4) engines. Contract signing is expected soon, with the first flight test in about two years.

• • •

R&D contract for 30 KW ion . . .

engine will be awarded shortly by NASA. The bidders: Ramo Wooldridge, Raytheon, Rocketdyne, Goodrich, Pratt & Whitney, Convair, General Electric, Aerojet-General, Hughes, Curtiss-Wright, Armour Research Foundation, and ITT Labs. Bids are now being presented orally and will be followed by evaluation and negotiation.

• • •

NASA also is evaluating . . .

bids on the liquid hydrogen Project *Rover* nozzle. Bidders are Rocketdyne, Aerojet-General, Pratt & Whitney, Reaction Motors, Bell, Martin and General Electric.

ELECTRONICS

"Projectitus" is a disease . . .

threatening the U.S. space program, in the opinion of Dr. Lloyd V. Berkner, president of the Associated Universites Inc. Berkner makes the point that engineers are diffusing effort in jamming a number of conveniently available experiments into every space vehicle just before it is launched. He says all the various projects should be replaced by one logical long-range program in which each launching is a step toward a goal of planetary exploration.

WE HEAR THAT

Major space system . . .

contract may go soon to the Electric Boat Division of General Dynamics, which has a 750-man R&D lab already working on several advanced systems . . . Melpar Division of Westinghouse Air Brake is laying off about 200 engineers with the expiration of some GSE contracts . . . The Washington office of General Motors' new defense products division is being increased . . . The General Accounting Office is getting ready to expand its auditing investigation of the *Polaris* missile system, which is being built largely under negotiated contracts.

Typhon System Shown by Navy

New Westinghouse radar plus existing birds will have two-way capability

by **Richard van Osten**

LOS ANGELES—Details of a new shipboard weapon system employing advanced versions of two existing missiles and a new long-range radar under development by Westinghouse Electric have been disclosed by the Navy.

The system, intended to back up the strategic offensive power of *Polaris* submarines, is scheduled for installation aboard more than 50 ships in the 1965-70 period.

(This development was first reported in M/R, Sept. 21, 1959, p. 24.)

Named *Typhon*, the system will have both defensive capabilities against enemy aircraft and missiles and offensive capabilities against enemy fleet units and shore targets.

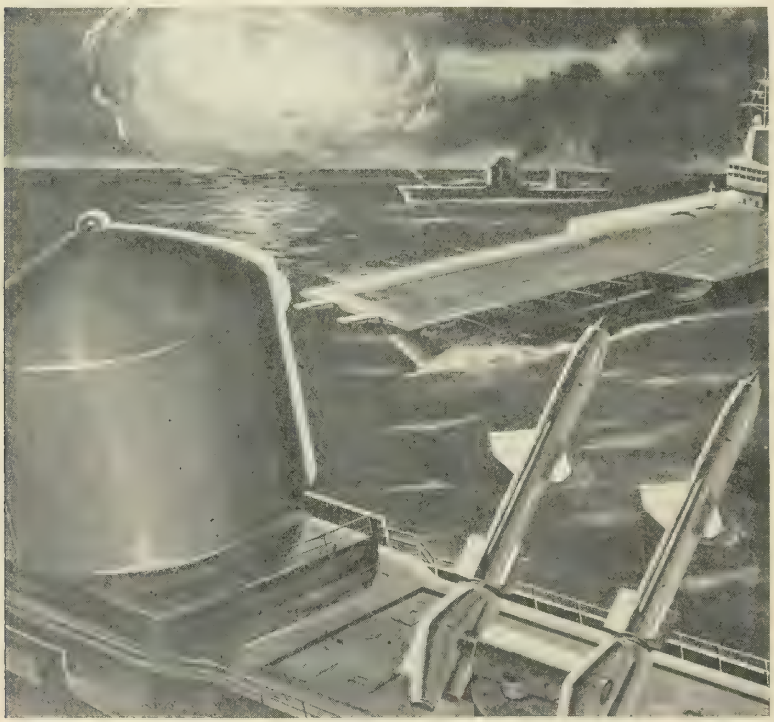
The Navy says it is capable of "long-range" shore bombardment.

The system's antiair capabilities extend from very short to very long slant ranges and to extremely high altitudes.

Typhon incorporates two missiles, the Super *Tartar* and Super *Talos*, now designated as Medium Range *Typhon* and Long Range *Typhon*, respectively. No hardware is yet in flight stage.

Key to *Typhon* rests in the radar concept developed by the Applied Physics Laboratory, Johns Hopkins University, according to Capt. E. B. Jarman, head of the ship-launched weapons program, Naval Bureau of Weapons.

A $38.5-million contract for development, design and production of a prototype for long-range *Typhon* radar has been awarded to Westinghouse Electric. The system as conceived by APL will incorporate high data rates and extremely high power features far in advance of present shipboard radar designs. Exact details are classified, although the Navy says it will be a phased array radar "with no ball bearings." However, monopulse and low frequency techniques are very likely under serious consideration.



ARTIST'S CONCEPTION of *Typhon* in action. Missile cruiser is shown with dome of new type of radar antenna which can keep track of several missiles at one time.

Requirements for longer range and detection of extremely small targets forced a major boost in radar power.

• **Better and smaller**—Another Navy problem it is hoped *Typhon* will solve is a lack of shipboard space for equipment that can perform multiple tracking functions. *Typhon* is specifically designed to handle a very large number of targets and to process target data at rates far greater than similar existing equipment.

The proposed radar will outperform any shipboard radar in its class presently available, and will be considerably smaller and lighter to fit "our small amount of real estate," the Navy says.

First complete *Typhon* system will probably be installed on a relatively large Navy vessel for further development—with emphasis on studies of the system's long-range capabilities with both radar and missiles. Eventually, it is hoped to fit all large class Navy ships with *Typhon*—destroyers, frigates, cruisers and aircraft carriers. There has also been some consideration of utilizing *Typhon* radar concepts on a single ship of a small fleet. The *Typhon*-equipped vessel would serve as a command ship and fire missiles from other ships in its immediate task force. In present state of development, however, *Typhon* is not tied to any specific ship in Navy programs.

• **Discrimination** — Although the Navy says *Typhon* is not parallel to antimissile capabilities of *Nike-Zeus* and it should not be termed an antimissile system, officers say they would "like to have discrimination" when asked if the radar portion can "separate" outgoing and incoming ballistic warheads.

Work on research missiles is going ahead at APL. Long Range *Typhon* (Super *Talos*) will be smaller and lighter than present *Talos*.

With so much emphasis on the Westinghouse radar, it is reasonable to assume *Typhon* missile development may have to wait for further development of the radar portion. Just how well this works out may determine exact configuration of the missiles and what equipment will be required within each missile.

The *Typhon* system is related in a very general way to APL's past work on the Navy's *Bumblebee* project from which came *Terrier*, *Tartar* and *Talos*.

The new system, however, will be a major break with the *Bumblebee* concepts—particularly that part affecting weapon control.

• **A big step**—Pointing out that work on *Bumblebee* is dropping off rapidly, the Navy says *Typhon* is a major "step" to take advantage of new technology rather than an "inching towards improvement."

In addition to its capabilities against sea and air targets, *Typhon* may also be used against land targets within the system's range. Existing launching systems for *Talos* and *Tartar* can be used for *Typhon* weapons. The system has no application for ASW, according to Navy statements.

It seems likely also that both Convair-Pomona, now producing *Terrier* and *Tartar* missiles, and Bendix, producing *Talos* at its Mishawaka, Ind. plant, could figure prominently in *Typhon's* future. Both plants are Navy-owned—a fact that might help in keeping missile costs down.

Typhon is assumed to have nuclear warhead capabilities, but a Navy spokesman declined to verify this. At a press conference, however, it was pointed out that "$38.5 million is a lot of money just to toss TNT into the air."

The system is named after a legendary monster with 100 fire-spitting heads.

NASA Nears Decision on Plasma Device Study Awards

The National Aeronautics and Space Administration is making final evaluations of bids on two proposals for feasibility studies on pulsed plasma propulsion devices.

Both contracts, expected to be awarded within the next few weeks, call for one-year studies. A decision will be made at the end of the year on whether to carry development further.

One of the two is a small device drawing up to one kilowatt, which would be used for attitude control of a satellite or space vehicle. The other, drawing 30 KW, could power deep space missions from a low orbit. Both devices would operate up to 60 days. Eleven companies bid on the 1 KW unit and eight bid on the larger one.

The 1 KW device might be powered by a solar-cell device such as is to be developed under Project *Sunflower*. The 30 KW unit could use the power from a SNAP-8 nuclear reactor.

Cost estimates for the first year are $200,000 for the 1 KW device and slightly under $500,000 for the 30 KW device.

Bidders on both contracts were Westinghouse, Rocketdyne Division of North American Aviation, Republic Aviation, Avco, General Electric Co., Aerojet General Corp., Plasmadyne Corp. and Marquardt Corp. Additional bidders on the 1 KW machine were Curtiss-Wright, American Machine and Foundry, and Convair Division, General Dynamics.

Nuclear Stage for *Saturn* by '68-'69

An upper nuclear stage for the *Saturn* vehicle is planned with a 1968 or 1969 launching date, Dr. Wernher von Braun has told a congressional committee.

A *Saturn*-nuclear vehicle could deliver a payload of 72,000 lbs. to a 300-mile orbit, Von Braun told the House Appropriations Subcommittee considering the National Aeronautics and Space Administration budget. The testimony, given in closed session March 16, was made public last week.

Von Braun compared payloads with the C-1 and C-2 *Saturn* configurations. The C-1 configuration consists of the 1½-million-lb.-thrust booster, a hydrogen-oxygen second stage with 80,000 lbs. thrust and the *Centaur*, with 40,000 lbs. thrust, as third stage. In the C-2 configuration, the second stage would be a cluster of four 200,000-lb.-thrust hydrogen-oxygen engines and the third stage would be a single such engine. Fourth and fifth stages might be added to the C-2 according to the mission.

The three-stage C-1 can put 4500 lbs. in a 24-hour orbit or make a soft lunar landing with about 2400 lbs. The first two stages can put 22,000 lbs. in a 300-mile orbit.

The three-stage C-2 can put 45,000 lbs. in a 300-mile orbit, 9000 lbs. in a 24-hour orbit and can land 5000 lbs. on the moon.

With a nuclear upper stage, Von Braun said, the payload would be 72,000 lbs. in a 300-mile orbit, 32,000 lbs. in a 24-hour orbit and 14,800 lbs. for a soft landing on the moon.

He declared the nuclear rocket "makes it definitely possible to fly a portion of this back to earth so you can bring samples back from the surface of the moon."

• **How to launch?**—Von Braun appeared to side with Harold B. Finger, NASA chief of nuclear engines, in the dispute over orbital or ground launching as the first flight test of the Project *Rover* nuclear rocket. He said:

"In principle it is possible to fly this right from the ground, but there are certain disadvantages to it. First and foremost there is the problem of tremendous radiation in the vicinity of the launching site. This runs at 1000 megawatts and you would have gamma radiation in the vicinity requiring very thick concrete shielding for the crew and probably within a mile or two miles from the takeoff nobody can stay because there would be a radiation hazard.

"In addition, if the thing aborts in the pad area we might as well evacuate the pad and forget it for the rest of our lives and build another one because of the contamination of the area."

Col. Jack L. Armstrong of the Atomic Energy Commission favors a ground launching as the first test of *Rover*—possibly by 1964 or 1965. Others who support a ground launching are Dr. Raemer E. Schreiber, who heads the nuclear rocket development program at Los Alamos Scientific Laboratory, and Krafft Ehricke, who heads the *Centaur* program at Convair Division of General Dynamics Corp.

NASA plans to contract with an industry study team for a complete examination of the pros and cons of all launch methods. Finger said bids on the study will be circulated soon.

Firestone May Eliminate Or Cut Back Missile Work

Firestone Tire & Rubber Co. is reducing the level of its missile division's activity to that involving current projects. The company gave no indication as to the future of the group after the *Corporal* system requires no further support. In addition to the cutback, certain supporting facilities may be sold outright.

Requirements for support of the *Corporal* assures operation of the organization for "a considerable length of time," according to Hugh I. Gibson, general manager. The cutback of operations in the Los Angeles plant is accompanied by a reappraisal of Firestone's engineering laboratory in Monterey, which may be sold. If a decision is made to sell this laboratory, it will be done so as to keep the lab operating as a unit.

Gibson said the cutback and reappraisal do not affect the other defense activities of Firestone.

Navy Presses *Polaris* Sub Test Shots

Members of Congress who witness trials of launching systems demand increase in number of subs

by James Baar

GROTON, CONN.—The nation's first two *Polaris* submarines are undergoing intensive testing of their launching systems as congressional pressure mounts for big increases in the *Polaris* submarine construction program.

In the last week, congressmen proposed increasing the number of *Polaris*-launching submarines in the FY 1961 budget anywhere from three to seven. They called for a total force ranging from the 40 plus sought by the Navy to more than double.

President Eisenhower's original budget provided for construction of three *Polaris* submarines and the purchase of long-lead-time items on three more. The President has now agreed to add long-lead-time items to still another six, bringing to nine the number for which long-lead-time items would be purchased.

• **More subs demanded**—However, a number of powerful congressmen made clear that they wanted more money for more submarines as quickly as possible—not long-lead-time items for submarines at some future date.

Sen. Clinton P. Anderson (D-N.M.), chairman of the Joint Congressional Atomic Energy Committee, said after an overnight cruise on the *Polaris*-launching submarine George Washington that he favored "doubling the order" for construction of subs. That would boost the number in the budget from three to six. Anderson said he favored a total fleet of about 45.

Sen. Henry Jackson (D-Wash.), a member of both the Senate Armed Services and the Joint Atomic Energy Committees, said he wanted seven more subs in the budget, boosting the total in the budget to 10. He said he wants a total force of 100. Jackson and other Joint Committee members accompanied Anderson.

The Navy itself has proposed adding six more. The total package would cost close to $1 billion.

On the other hand, the Administration proposal would be much cheaper. Long-lead-time items—mainly nuclear reactor components—cost about $20 million for each ship.

• **Training shots**—The George Washington during the next few months will continue to launch from submerged and surfaced positions both *Dolphins*, dummy operational missiles, and *Sabots*, missile slugs.

The Lockheed *Dolphins* are instrumented dummy *Polarises* that duplicate the operational missile both in shape and weight. The Westinghouse *Sabots* are 2500-pound short cylinders that are fired from the *Polaris*-launching tubes along with two and a half tons of water.

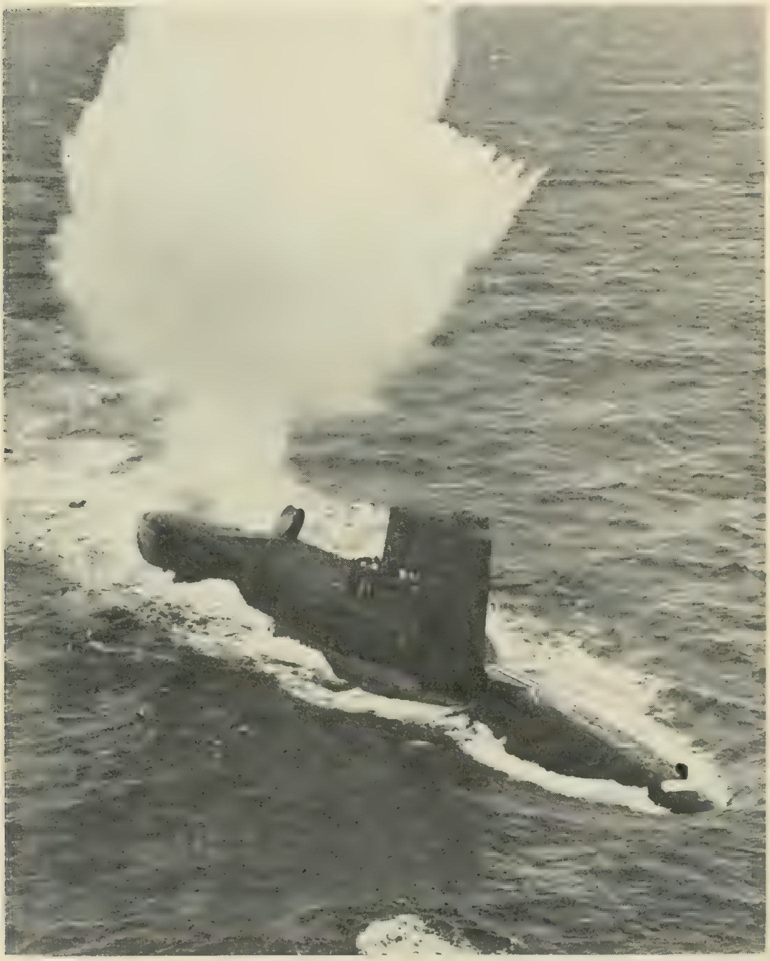
The George Washington launched 10 *Sabots* while the Joint Committee was aboard. One *Sabot* was launched at the surface near the mouth of the Thames River about a mile from the Electric Boat shipyards at Groton. The other nine were launched from beneath the surface of the Atlantic off the New England Coast.

Congressmen and high-ranking Naval officers stood by the George Washington's tall sail while one of the great missile tube doors swung back. The *Sabot* roared skyward in a mushroom-shaped geyser of water and was recovered by a tug.

The Patrick Henry—second of the 5700-ton class of *Polaris* subs—had already headed for open water after commissioning ceremonies at the Electric Boat pier.

The Patrick Henry will begin launching *Sabots* later this month while lying along her pier. She will begin firing *Dolphins* next month.

Both submarines—first the George Washington, then the Patrick Henry—are scheduled to be on station with their missiles by the end of the year. Rear Adm. L. R. Daspit, commander of the Atlantic Submarine Force, said



SURFACE FIRING of a 2500-pound slug and two and a half tons of water from a tube of the *Polaris* Submarine George Washington near the Connecticut shore.

during the commissioning ceremonies that the Patrick Henry would go on station in December.

Navy Refutes Charges That It Neglects ASW Proposals

Rear Adm. Rawson Bennett has brushed aside charges from some industry officials that the Navy is disregarding many new proposals for combating the growing submarine threat.

Bennett told the House Military Appropriations Subcommittee in newly released testimony that between Jan. 1, 1958, and Dec. 31, 1959, the Navy received 486 unsolicited ASW proposals.

He said 386 of these included cost information; the other hundred did not. He said that 48 of the total number of proposals were offered at no cost to the government.

Bennett said that over the period the Navy has obligated about $26 million for 155 of the total number of proposals. He said 24 of the no-cost proposals also have been accepted; 17 rejected; and seven remain under consideration.

As for criticism of the Navy's handling of ASW proposals, Bennett said:

"You have to recognize it is a great American right to be a little upset if someone doesn't buy your own particular product."

news briefs

FIRST NAVIGATION SATELLITE—The nation's first R&D navigation satellite *Transit 1B* soared an approximately 400-mile circular orbit. The 265-pound ARPA Navy satellite was launched from Cape Canaveral at 7:02 A.M. EST April 13 by the Air Force's latest space booster, the two-stage *Thor Able-Star*. The Aerojet STL's *Able Star* had a start-restart engine that hurled the satellite into a circular orbit from the elliptical into which it originally was launched. The satellite carried two ultrastable oscillators within its 36-inch diameter operating over four bands. Six ground stations were set up to pick up the satellite's signals. Navigational fixes will be obtained from the signals by measuring the Doppler shift. *Transit 1B* is essentially a repeat of the first *Transit* shot last September 14. The first *Transit* failed to get into orbit. One of the prime uses for *Transit* will be to serve the Navy as another navigational check for *Polaris*-launching submarines. The operational system will use four 50-pound satellites.

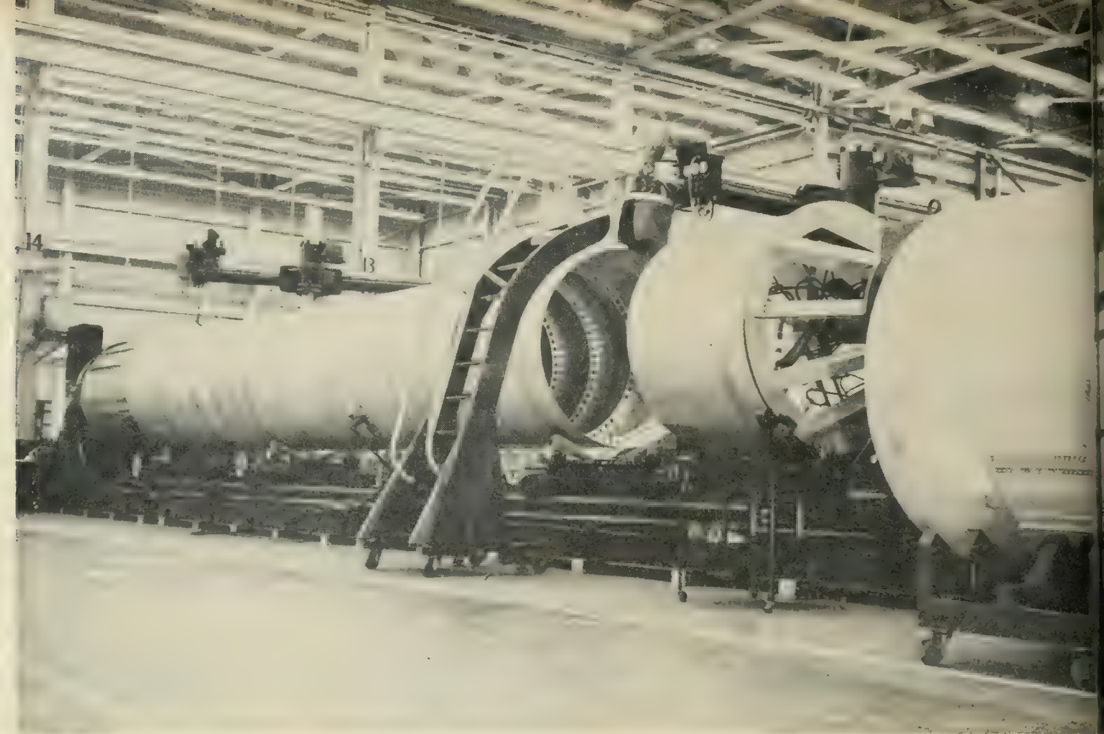
BRITISH CUT MISSILES—In a major defense shift, Britain is reported ready to cancel its *Blue Streak IRBM* and antiaircraft *Super Bloodhound* missile as a first step toward buying missiles from the United States. More than $280 already has been spent on the *Blue Streak*. Government officials were said to feel the British economy could not support large-scale missile development and that it would be more economical to procure needed weapons from other countries.

***SAMOS* R&D $200 MILLION**—The Air Force is budgeting $200 million for the development of the *Samos* Television reconnaissance satellite in Fiscal 1961. Another $12 million is earmarked for re-entry vehicle studies, penetration aids, storable noncryogenic fuels and silo-type launcher studies for *Atlas*, *Titan* and *Minuteman*.

STL TO GET $44 MILLION—Space Technology Laboratories would receive $44 million for research consultative services for the Air Force under the 1961 Budget. The Air Force also plans to pay Rand Corp. $13.5 million; Lincoln Laboratories $21 million; Mitre Corp. $20 million and ANSER $1 million in the coming fiscal year.

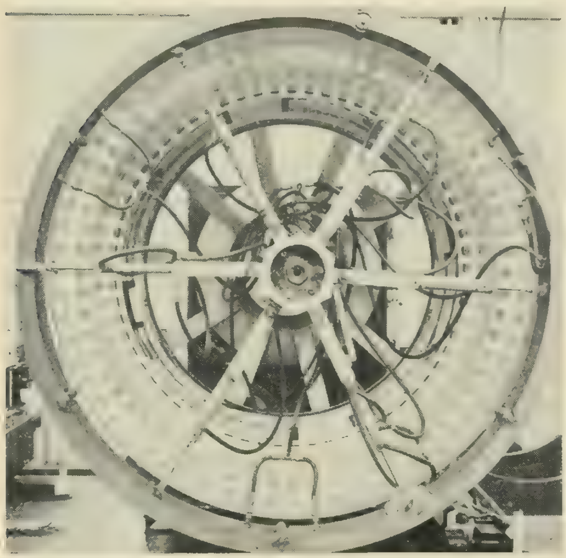
A Clear Middle Eastern View from Tiros I

PHOTOGRAPH WAS TAKEN by *Tiros I's* wide-angle camera from 450 miles over the Red Sea on April 4. Map at left helps to identify the dark strip to the west as the Nile River. The Sinai Peninsula is flanked by the Red Sea to the west and the Gulf of Aqaba to the East. In upper left corner is the Mediterranean Sea.



an M/R exclusive . . .

Saturn Fabrication: Spectacula



DETAIL OF circumferential welding machine for outer tank welding shows internal back-up bar arrangement. The "Serpentine Design" can be collapsed and expanded by pneumatic action, provides clamping pressure and precision fit of joint.

by Hans H. Maus*

HUNTSVILLE, ALA.—On July 27, 1959, a small, yet significant, ceremony took place in Building 4707 of the Fabrication and Assembly Engineering Laboratory, Army Ballistic Missile Agency, at Redstone Arsenal. It marked the completion of the last *Jupiter* type airframe to be fabricated by the Agency. Immediately thereafter the Master Mechanic Organization took over and retooling of the shops for the *Saturn* project began with all possible speed.

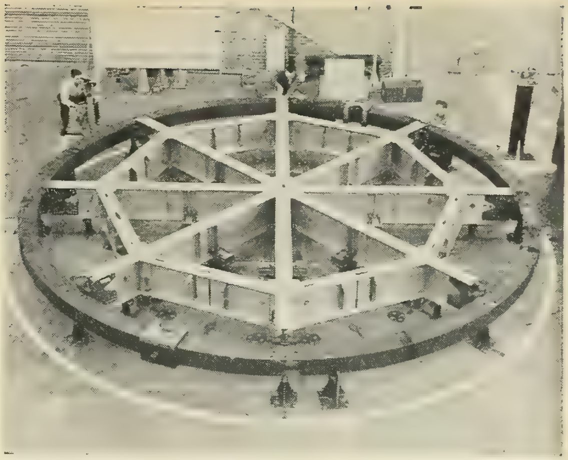
A full-size outline of the *Saturn* booster diameter which had been painted on the end wall of the building by the tool designers served as a continuous reminder of the new and challenging assignment and of the schedule which was to be met.

It was half a year later—on Feb. 1, 1960, and coincidental with the fourth anniversary of the Army Ballistic Missile Agency—that the first *Saturn* booster tank cluster could be displayed to the public.

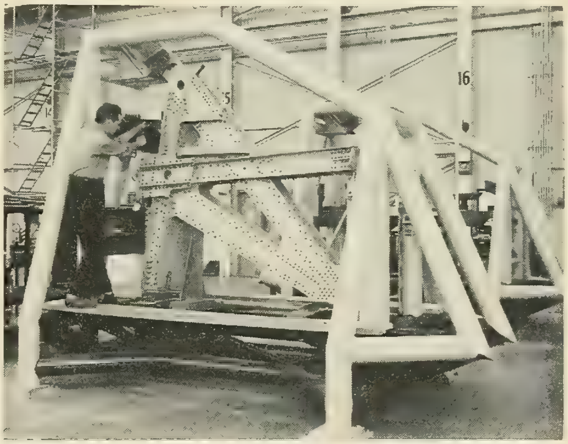
What had been accomplished during a relatively short period of time by dedicated tool engineering and production personnel of the Agency and by equally dedicated personnel of numerous companies supporting the project can be seen, to some extent, from this pictorial report.

**Chief of the Fabrication and Assembly Engineering Laboratory, George C. Marshall Space Flight Center, Huntsville, Ala.*

ASSEMBLY of 70-inch diameter tankage is done on circumferential welding machine from cylindrical sections and bulkhead sections preassembled on other tooling. For joining, tank sections are rotated under stationary welding head. While tank lengthens by sections which are added, one at a time, tail stock of fixture travels over entire length of tool base.



"SPIDER BEAM" assembly, part of adapter section, being aligned on locating fixture. Tool ring, later used for handling and transportation of booster, is assembled on same fixture. Structural members are from 7075 aluminum.



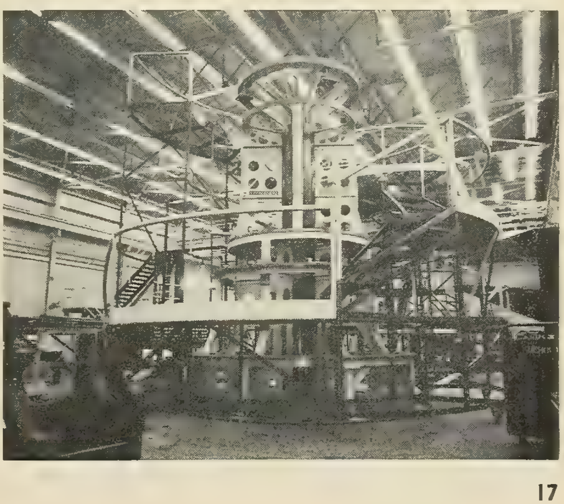
OUTRIGGER SUPPORT frames are assembled separately before being joined to tail. Huckbolting is used for assembly. Four inboard and four outboard supports are required for a single booster tail section.

uccess Story

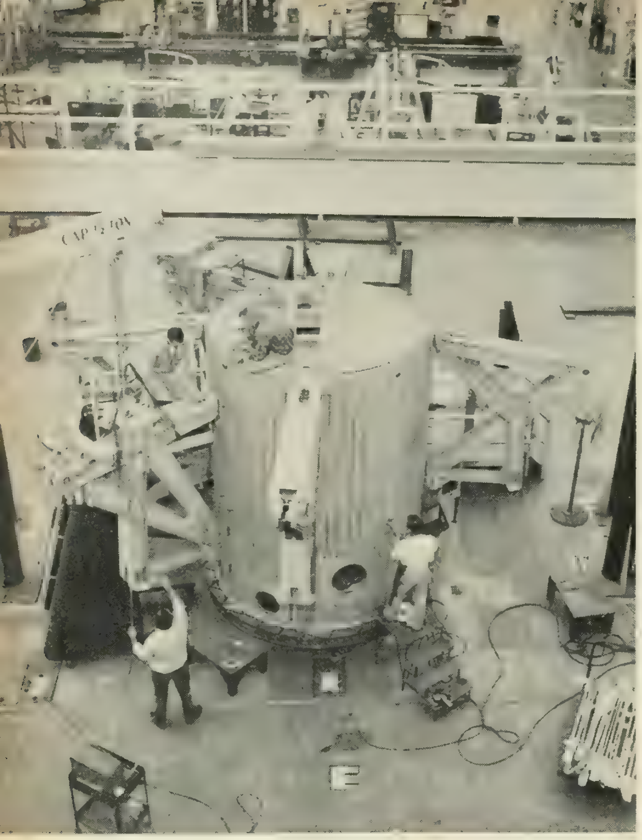
• **Basic description**—Basically the *Saturn* booster airframe consists of one large center tank of 105 in. diameter around which eight outer tanks of 70 in. diameter are clustered. The front tie of the tankage is furnished by the "Adapter Section" which also creates the base for the upper stages to be carried by the booster. The rear tie of the tankage is accomplished by the "tail section" which supports the eight rocket engines which power the vehicle.

The tank diameters have been chosen to permit the use—in part at least—of tooling which had previously been developed for the *Redstone* and *Jupiter* programs. Considerable modifications were required, however (as could be expected), and many additional pieces of tooling were needed. This was true particularly for the adapter section, and for the final asesmbly of airframe and booster vehicle.

In the fabrication of the tankage, specific emphasis is placed on reliability. With a few exceptions the tanks are fabricated from 5456 aluminum alloy. Skin sheets are milled to a pattern in the flat condition (which is done for weight savings) then rolled and joined to cylinders by automatic fusion welding. Ring frames, spot-welded inside, complete

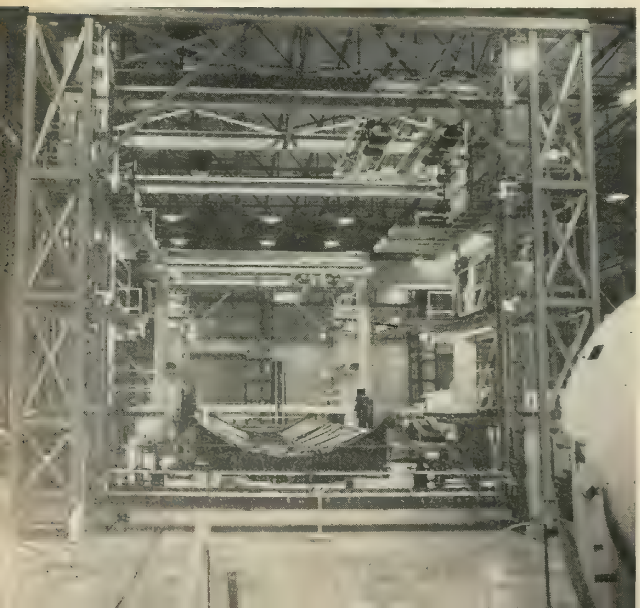


VERTICAL FIXTURE which facilitates assembly of tail barrel. Component parts such as thrust rings, longerons, shear panels, etc., are handled on separate tooling.



PREASSEMBLED OUTRIGGERS and tail barrel are joined on optical alignment stand. Turntable permits precision location and installation of support frames and of mounting brackets for outer tanks, rocket engines and engine swivel actuators. Tail barrel has same diameter as center tank, is later bolted to it. Main columns of stand are filled with oil.

BOOSTER FINAL assembly station shows part of assembly tool in center. Full adjustability is provided in positioning stands operated from a central location outside the station. Movable service structures are equipped with hoists and elevators, making it possible to conduct assembly at three elevations.



the cylindrical sections.

Bulkheads are formed from one piece of material in a combination shear-spin-machining operation, and chemically milled in certain areas for weight reduction. They are joined to the cylindrical sections by internal fillet welds. Dimensional accuracy of components parts is achieved by routing the skin sheets to lengths and by parallel trimming of the tank sections.

• **Optical alignment**—The overall assembly fixture, on which the individual cylindrical sections and bulkhead sections are joined into a tank, provides for alignment of the component parts by built-in optical equipment. The fixture incorporates provisions for test-weld specimens to be welded under identical conditions immediately preceding the production weld. Machine welding is applied.

Radiographic inspection and hydrostatic testing are used, after the tanks are completed, to check for weld quality and soundness.

Major structural items such as adapter section and tail section, as well as shrouding are fabricated from preassembled component parts joined on special alignment fixtures. Most of the tools designed for these items serve a multitude of operations.

• **Final assembly**—The final assembly of airframe and booster vehicle is handled on the *Saturn* Booster Assembly Station. The station consists of the assembly fixture proper (with fully adjustable cradle supports, tool rings, etc.), and of scaffolding structures which can be closed in to provide access to the booster. The structures are provided with hoists and elevators and allow parallel assembly operations at three elevations.

Two large tool rings are used to place the booster on the fixture. They tie in to the eight "spiders" of the adapter section in front and to the out-rigger support frames in the rear. The tool rings are segmented for ease of installation. Once assembled to the booster they form an integral part of it without which it cannot be handled or transported. They are disassembled, finally, after the booster has been shipped to the firing site and has been moved to the launch site.

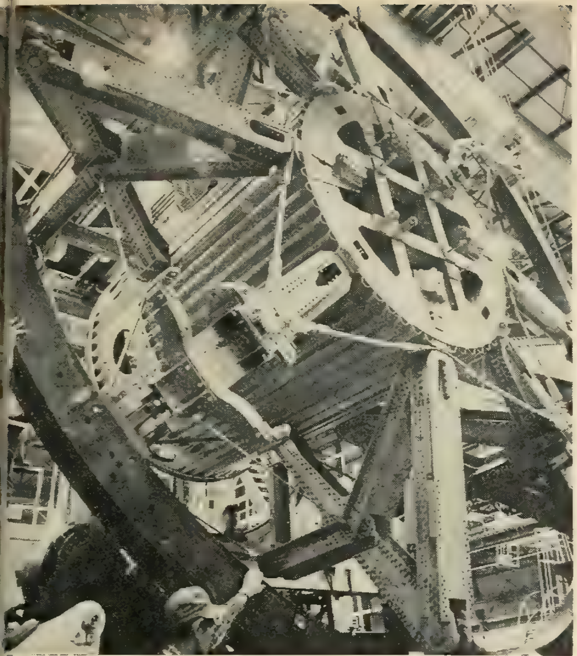
The assembly of the tank cluster is handled in a simple manner: The tail section is moved in first and the center tank connected. Then the adapter section is added. Next, the outer tanks are filled in from above, one at a time, while the fixture is rotated.

• **Special features**—A number of special features are incorporated in the assembly tool which allow for alignment, weighing, and determination of center of gravity. The alignment is accomplished by optical means and by push-button remote control located on an elevated platform in the rear of the station. Weight and center of gravity are determined by precision load cells and optical measurement.

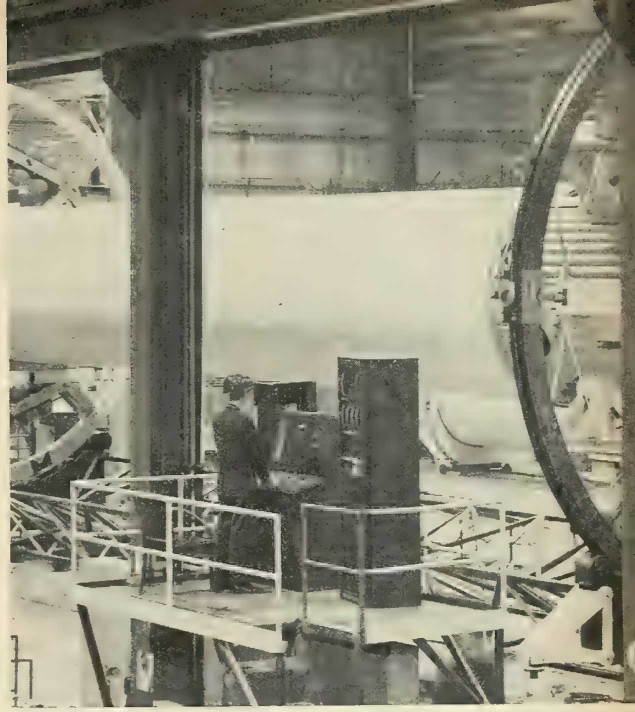
After the booster is assembled all special equipment is disconnected from the tool and the basic elements (rings, cradles and trusses) are converted into a transportation vehicle. For this purpose the assembly tool is jacked-up hydraulically on four points and front and rear "walking gears" are moved under. The walking gears consist of tandem wheel arrangement which can be steered separately for transportation.

In this fashion the assembled booster can be transported to functional check-out and captive testing and in the same manner will finally be transferred to the river dock and onto a barge for shipment to the launch site.

Editor's note: The Saturn *tank cluster shown in some of the pictures does not carry the adapter part (of the adapter section) with which the booster connects to the upper stages. Likewise, engines and shrouding are not yet assembled.*

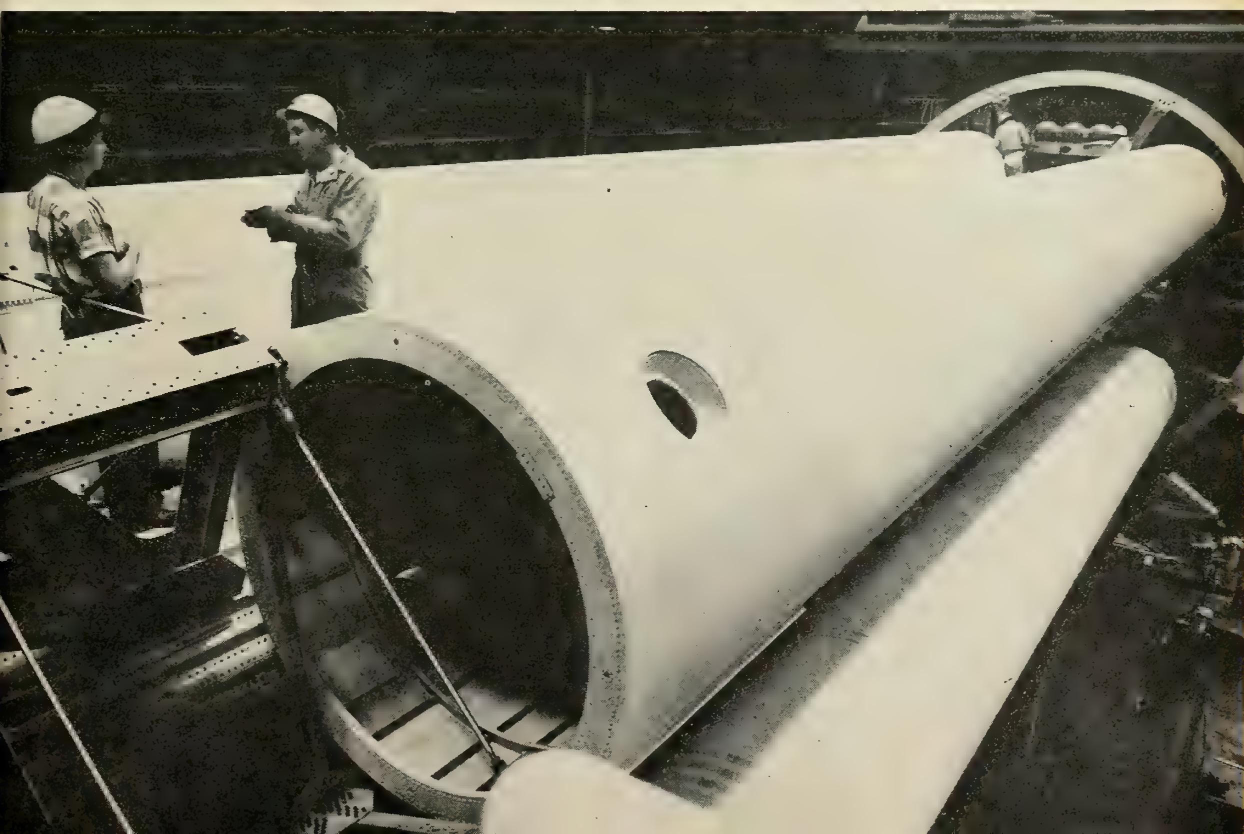


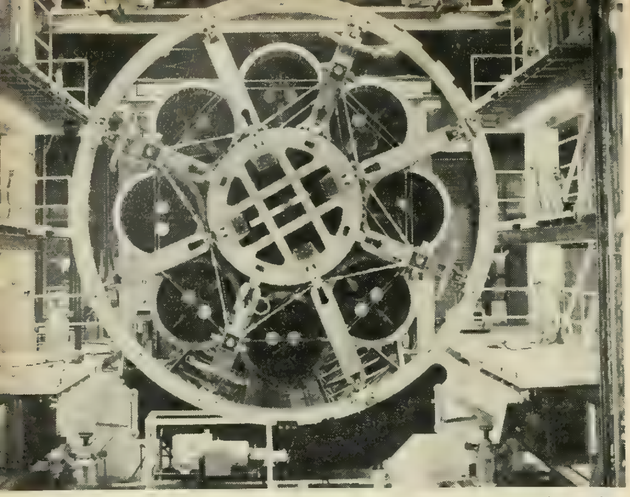
COMPLETED "TAIL SECTION" subassembly, the 24-foot-diameter tool ring assembled to it, is hoisted on rear cradle support of *Saturn* assembly station. In a succeeding operation, the large center tank will be moved in and connected.



TRANSDUCER READOUTS and push-button remote controls are used to maintain precision alignment. Same equipment permits rotation of entire fixture for assembly of outer tanks, engines, shrouding, etc.

TOP VIEW OF assembly station shows four outer LOX tanks installed. In following operation, the outer fuel tanks will be assembled. Fixture stands three stories high; distance between tool rings is 63 feet.





REAR VIEW of partially assembled booster shows tail section in foreground. Four outer and four inner thrust pads are installed; engines will be mounted on them. The large tool ring connects to eight outrigger support frames to allow rotation.

EDITOR'S NOTE

Preliminary design on the 1.5-million-pound-thrust Saturn *booster was started at ABMA about April, 1957. This early configuration would have used four Rocketdyne E-1 engines developing 330 K each.*

In July, 1958, this proposal was submitted to ARPA. ARPA specialists suggested using eight Jupiter *engines instead of four E-1 engines in order to save some $50 million in engine development money which was not available.* Saturn *finally was approved by ARPA and funded by $10 million to demonstrate the feasibility of a cluster.*

The original ARPA-ABMA program would have flight-tested the booster in late 1960; with operational flights following in 1962-63. After one year, however, the project faltered because of inadequate funding.

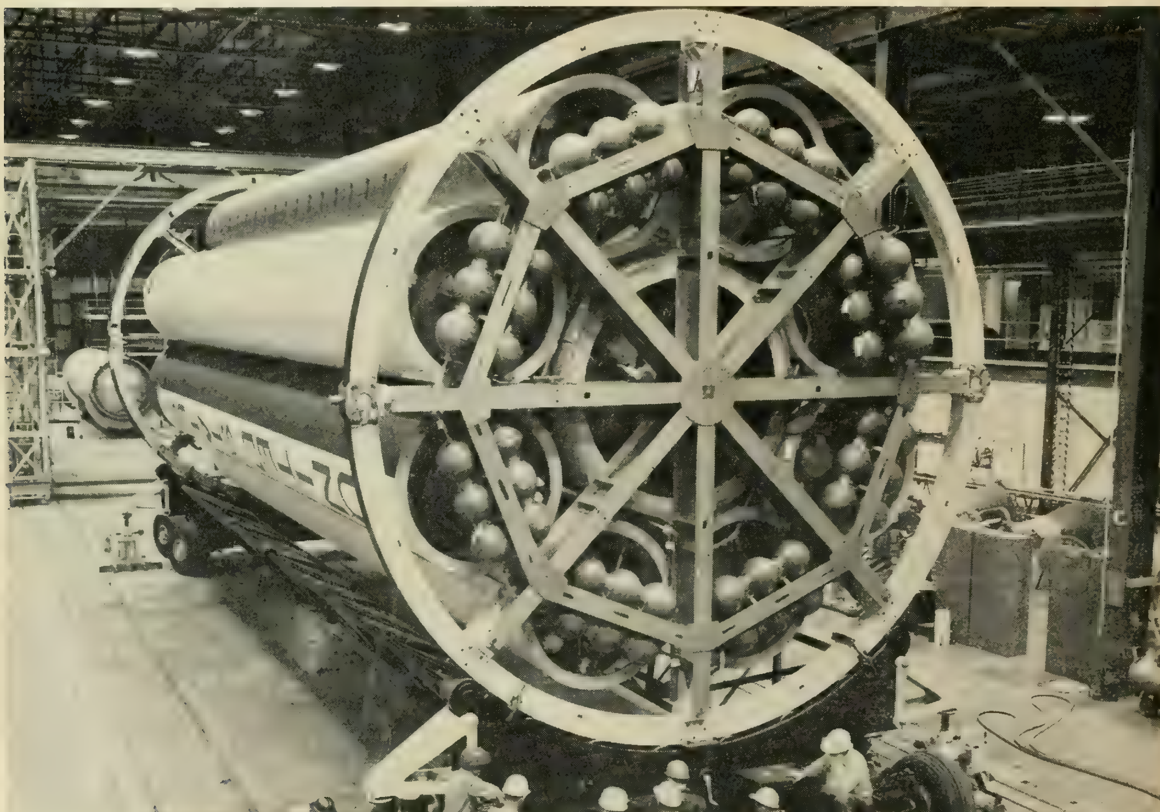
In FY 1959, $34 million was requested by the Saturn *team and $34 million was received. The second year (FY 1960) $140 million was requested, but only $70 million was received. The third year (FY '61) the team requested $250 million. The ARPA budget called for only $140 million.*

Also jeopardizing Saturn's *future in 1959 was an arbitrary DOD ruling that no military missions existed beyond 600 miles. At one point, according to recent testimony by ex-ARPA director Roy Johnson, DOD R&E chief Dr. Herbert York had ordered the* Saturn *project cancelled.*

Late in 1959, the President ordered Saturn *and the Development Operations Division of ABMA transferred to NASA. NASA asked that the* Saturn *funding be increased for FY '60 from the $140-million DOD-ARPA figure to $246 million—just $4 million short of what the* Saturn *team had asked. NASA threw in another $8 million out of its liquid propulsion budget for good measure.*

After announcement of the intended transfer, NASA and the Saturn *team quickly arrived at a decision to use liquid hydrogen-oxygen engine clusters for* Saturn's *upper stages, and invitations to bid were sent to industry.*

Present estimates of Saturn's *schedule are close to the original schedule worked out in 1958 with the first full static test in 1960 and the first flight test in 1961.*



"WALKING GEARS" designed and supplied by Systems Support Equipment Laboratory, ABMA, are being installed on the fixture. They provide for transportation of the booster on the basic assembly tool without need for reloading. Front and rear wheels can be steered separately for ease of maneuver.

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Optics Play Large Part in DAMP

Program uses unique optical instruments designed to investigate re-entering missiles

Data from optical instrumentation aboard the recently modified Army Ordnance range ship USAS American Mariner (M/R, Feb. 29) will play an important part in design of future anti-missile systems.

Part of ARPA's Downrange Antiballistic Measurement Program (DAMP), the range ship and a team-mate C-130 aircraft gather optical data on re-entering missiles for Project *Defender*. The floating and flying Laboratories carry a number of precise and unique optical instruments to photograph, measure, and record physical phenomena surrounding re-entering bodies.

Optical measurements cover the light spectrum from far infrared through ultraviolet. Data recording and reduction facilities translate this information for use in research on missile defense.

During an operation, the American Mariner—and the aircraft—are spotted downrange near the expected impact point. On board the ship, tracking radars acquire the re-entering nose cone and the optical instruments, slaved to the radar, begin their photographic and recording functions. In case the radars are unable to acquire the target, the optics may be controlled by both or either of two optical directors.

Instruments in the C-130 are manually aimed and operated on the basis of visual acquisition and tracking.

On completion of a mission, film is processed and copied, and chart and oscillograph records tabulated. Film and original recordings are sent to Stamford, Conn., for further reduction and analysis.

• **Shipboard instrumentation**—A wide variety of optical instruments have been designed or adapted for use aboard the DAMP ship.

Special ballistic cameras provide a spectral record of the re-entry phenomena as a function of both range time and spatial orientation.

Spectral sequence cameras provide an instant-by-instant record of the spectra of the re-entering bodies through the ultraviolet, visible, and near infrared.

A four-barrel photometer provides absolute calibration points in the spectra shown by the photographic recording instruments. Each barrel of the photometer uses a photomultiplier tube equipped with a filter passing the narrow regions of the spectrum of special interest.

Measurements in the intermediate and far infrared are provided by radiometers. One is a wide-angle instrument and the other a high-precision, high-sensitivity, small-field-of-view instrument with 12-inch optics.

A high-resolution cine camera provides accurate information on the makeup of the re-entry complex. This instrument uses a 40-inch lens and 70-mm film to provide high-quality, high-magnification motion-picture records of the re-entry bodies.

A 30-element infrared scanner makes instantaneous radiation measurements on the individual bodies of the re-entry complex simultaneously, covering a 5° by 15° portion of sky on a 30-channel oscillographic recorder.

In addition to these instruments, separate 35-mm boresight cameras, with a variety of lenses, are available for installation on hand-tracked instruments or on remotely controlled pedestals.

Data-recording equipment, timing units, audio tape recorders and control switches are located below decks along with checkout, repair, and electronic calibration facilities.

The common Atlantic Missile Range timing code is generated aboard ship and supplied to the optical instruments in the form of one pps coded GMT grad. Also available are 0.1, 0.01, and 0.001-second timing pulses, but these are not used with current instrumentation.

Meteorological data from radiosonde balloon flights—taken before and after each test—are furnished for the reduction of the optical data.

Following each test, radar trajectory data—slant range, azimuth, elevation, velocity, acceleration, altitude, and aspect angle—are supplied for the optical data processing.

• **Airborne instrumentation**—Instruments aboard the aircraft are limited to a 70-mm cine-spectrometer, a 2-barrel photometer, a R-4K1 radiometer, and a boresight camera. Addition of ballistic trajectory cameras is currently being investigated.

• **Motion-picture cameras**—Four motion-picture cameras are used to photograph the re-entry complex. Three of these are Flight Research Corp. 35-mm Model IV C mounted on slave pedestals 1, 3, and 4, where they function as boresight cameras for the other instruments mounted on these pedestals. Two of these cameras have 6 in. focal length f/3.5 lenses (8° x 10° field of view) and the third a 3 in. focal length f/2.3 lens (16° x 20° field of view). A reflex sight with an illuminated reticle is mounted in front of each camera to provide a boresight grid at the film plane. Range time is recorded in the form of coded one pps marks on both edges of the film (one ahead and one following the exposed frame).

The fourth camera is a Flight Research 70-mm with a 40 in. focal length f/8 Zoomar lens. With a 2¼ x 2¼ inch film format, this instrument has a field of view of 3.2° x 3.2°. The 40 in. lens is being used in an effort to evaluate the limit imposed by shipboard environment. If results are favorable, higher resolution systems—possibly even such instruments as the ROTI, IGOR or SMT high-resolution cameras—may be installed later and used for the provision of higher-resolution photography.

• **Ballistic cameras**—In its simplest form, the ballistic camera consists of a photographic plate at the focus of a wide-field lens equipped with a shutter. It is pointed at some predetermined azimuth and elevation. The shutter opens before the target moves into the field, and closes after the target moves out of the field or disappears. A bright, essentially point-source target—such as a missile in launch or in re-entry—will be recorded as a streak across the photographic plate.

By the addition of a chopper which obscures the lens or closes the camera at some known rate, relative time and, hence, target velocity can be determined from the simple streak record.

Aboard the American Mariner, two ballistic camera arrays are installed. Each array consists of a cluster of four cameras mounted in such a way that

heir individual fields of view (37° x 45°) can be oriented to cover a rectangle of the sky 90° x 74°, or practically any other combination of the four individual fields of view.

These cameras are not stabilized but are mounted on a heavy tripod bolted to the deck. An azimuth adjustment head allows the entire array to rotate through 360°.

The individual cameras are Fairchild K-19B aerial reconnaissance cameras modified for this special application. Lenses are 12 in. focal length. The photographic plates are 8 x 10 inches. Film can also be used.

One array of four cameras is used undispersed; the other array is fitted with transmission gratings in front of the objectives. These gratings have a ruled area of 153 x 128 mm with 300 lines/mm and are blazed for 6000 A. The dispersion is about 110A/mm in the focal plane, and the resolution at full operation is about 10 A in the center of the field and about 15 to 20 A at the edge of the field.

• **Spectral sequence camera**—One drawback of the ballistic camera is that it cannot resolve any target structure in the direction of target movement. For example, if a target is leaving an appreciable trail, whose geometric and spectral features are naturally of great interest, these features cannot be obtained from the ballistic camera record. Similarly, two targets, one immediately behind the other, cannot be resolved and may, indeed, obliterate the timing marks unless there is sufficient lateral camera motion to separate them.

Resolving target structure along the line of motion requires a "snapshot" picture, and for this purpose two cine spectrometers have been provided on the slave pedestals aboard the American Mariner. These cameras have relatively narrow fields of view and must therefore be pointed close to the target to be effective.

The cameras used for this purpose are Hulcher 70 mm rapid-sequence cameras provided with Bausch and Lomb replica transmission gratings.

A four-channel photometer system monitors simultaneously the intensity of one-re-entry object in four narrow wavelength bands in the region from 2000 A to 8000 A. Each channel consists of an f/4.6, 4-inch diameter crown-glass objective lens, a crown-glass field lens, an iris to provide an adjustable field of view, a filter and a photomultiplier tube. Presently used spectral regions are:

1. 114 A wide centered at 5896 A
2. 120 A wide centered at 7636 A
3. 37 A wide centered at 6718 A
4. 34 A wide centered at 4609 A.

Each photometer channel is linearly recorded on two Sanborn channels, one normally at full gain (i.e. the gain is set so that system noise just shows) and the other at a gain reduced by a factor of 20 or 10 depending on anticipated intensities. This dual-channel recording provided increased dynamic range. Two four-channel recorders and four dual-channel amplifiers are required for the installation.

• **Infrared radiometers**—The Model R-4K1 Radiometer was designed to meet the requirements for making radiation measurement of small, remote and fastmoving targets against a variety of day and night backgrounds. Special features were incorporated to make it effective and flexible in this application, where conventional radiometers were incapable of providing the desired functions and data. One example is the incorporation of a field of view which can be made as wide as three degrees.

The problem of background radiation was solved by the use of a space-filtering reticle, instead of the total-radiation chopper generally used in radiometers. In this instrument, space-filter chopping rejects uniform background signals by a ratio of 10,000 to 1, providing a radiometric contrast measurement of the target.

In addition to the wide-field radiometer DAMP required a research radiometer system with maximum obtainable sensitivity and with a field of view

Lightweight Maser Developed

A NEW RUBY maser amplifier, developed for U.S. Army by Hughes Aircraft, is said to be the smallest and easiest-to-operate of its kind and can extend by 10 times the range of many Army electronic systems. The "super-detector" amplifier weighs only 25 pounds and uses a 12-ounce magnet costing only $10. It was designed for an Army portable radar receiver for combat use. Such highly sensitive amplifiers also find use in space communications, ballistic missile detection, and radio astronomy.

in the order of ½° to 1°. Other basic requirements for this radiometer were ease of interchanging detector and filters. The R-12A1 Radiometer was selected because it has all of the desired characteristics. The R-12A1 radiometer system consists of two optical heads, four plug-in detector packages and two sets of electronics. It is essentially a two-channel system.

The optical system was designed to provide extreme radiation collecting power with the largest possible field of view. This was obtained through the use of a Pfund pierced-mirror optical system. This arrangement comprises a paraboloidal mirror 12 inches in diameter plus a large pierced flat mirror placed at 45° to shorten the optical path. The resulting system has an effective focal length of 14.4 inches and a focal ratio of f/1.2. The obscuration is less than 5%, and the field of view can be made as wide as ½° to 1°.

• **Infrared spectrometer**—One possible technique for distinguishing the various bodies in the re-entry complex is by means of spectral differences in their radiations. For example, the aerodynamic properties of the nose cone may result in a spectrum which is relatively rich in some wavelength range.

In order to determine the spectral characteristics of the re-entering complex, Barnes designed an infrared spectrometer to be mounted on a radar-directed pedestal. Its field of view is a 1/3° square, established by a field stop in the focal plane of a 6 in. diameter Cassegrain collection system.

• **Multi-element scanners**—One important item to be investigated in the course of Project DAMP is the radiation-time history of each of the object[s] in the re-entry complex. In an attemp[t] to obtain this information, a thirty-ele[-]ment lead sulfide scanner was rebuilt.

The optical system consists of a [...] in. aperature Cassegrain primary an[d] flat secondary mirror which is oscillate[d] from side to side to provide the scan[-]ning action. The image is swept acros[s] a thirty-element lead sulfide detecto[r] array placed in the focal plane of th[e] optical system. The 30-element arra[y] subtends a 5° vertical field with 3 mil[-]liradian resolution, and the secondar[y] mirror sweeps a 15° horizontal field.

Currently under modification fo[r] shipboard use is an Eastman Kodak 50[-]element PbS Scanner with improve[d] resolution. This instrument scans [a] field of view 3° high by 12° wide wit[h] an instantaneous detecting element o[f] 1 mil.

How Hawaiian Station 'Hula' Tracks Orbiting *Discoverer*

SIGNALS SENT from Kaena Point, Hawaii can change orbital period on *Discoverer* satellites. Tracking station is one of six used in program.

Discoverer satellites, in polar orbi[t] around the earth, take their order[s] from a tracking station called "Hula" located on a high bluff at Kaena Point Hawaii, 35 miles from Honolulu Signals sent from Kaena Point ca[n] change the programer aboard the sat[-]ellite to correct its orbital period. The space vehicle then sends back a message signalling acknowledgement and compliance with the order.

During a *Discoverer* launch and orbit, the Lockheed/Air Force Kaena Pt. station—one of six AF instrumentation facilities in the program—is used to track and collect data from the satellite as well as serve as a control center for orbit correction.

The station is manned some two hours before launch time. The equipment is checked out and calibrated and voice and teletype communications are established with the Satellite Test Center in Sunnyvale, Calif.

At T minus 10 minutes, Kaena ties in to a direct voice line to the Vandenburg blockhouse to listen to the countdown and lift-off of the *Thor-Agena* vehicle.

After lift-off, launch and orbit injection data are computed by Lockheed's Scientific Research Laboratory at Palo Alto. Acquisition data is then fed to STC which sends it out to Kaena, Vandenberg, and Kodiak.

At Kaena, the tri-helix acquiring antenna is aimed by the received information and awaits appearance of the satellite. A few minutes after Kodiak announces acquisition, the *Discoverer* races into range of the Hawaiian tracking station. The tri-helix picks it up and the 60-foot TLM-18 antenna locks on the satellite. A verlort (very long-range tracking) radar, slaved to the big dish, begins tracking.

During the following hours, while

the satellite is within range, it is tracked, necessary programing commands are given, data are received.

• **Hawaiian eye**—About 26 hours after launch, Hawaii becomes the center of attention as the *Agena* completes its sixteenth pass and heads around the earth on the 17th when an attempt will be made to recover the capsule contained in the nose.

Recovery forces have been deployed. The Joe E. Mann telemetry ship is spotted at a point between Hawaii and Alaska, the RC-121 radar planes and the C-119 aerial recovery aircraft are cruising their assigned stations, and the USS Haiti Victory and Dalton Victory are patrolling the area for backup.

After crossing over Kodiak, the capsule separates and the retro-rocket fires, slowing down its orbit speed to allow it to enter the earth's atmosphere in a gradual curve. The Joe E. Mann monitors the capsule separation and retro-rocket firing with its telemetering gear. The TLM-18 antenna at Kaena picks up the capsule upon re-entry and parachute deployment and notifies the Hawaii Control Center which is directing the recovery force. With their radar, the RC-121's vector the C-119 aircraft which home in on the capsule's radio beacon. Aerial pickup can be made with trapeze-like nets suspended from the C-119's which snag the parachute with the attached capsule and reel it into the plane.

Several firsts have been accomplished with the program:

1) Launch and orbit of large, heavy satellite vehicles;

2) Attainment of polar orbit;

3) Ability to maneuver a satellite in orbit;

4) Stabilization of a space vehicle before and after change in attitude;

The project also claims more successful orbits than any other program and the first capsule ejection and reentry.

Discoverer Operating Facilities

Command, control, and direction—**Satellite Test Center, Sunnyvale, Calif.**

Launch—**Vandenberg AFB, Calif.**

Tracking and Acquisition—**Vandenberg AFB, Calif.; Kodiak, Alaska; Point Mugu, Calif.; Kaena Pt., Hawaii.**

Data Processing—**Lockheed Scientific Research Laboratory, Palo Alto, Calif.**

Recovery—**Hawaiian Control Center; Kaena Pt., Hawaii; C-119 Test Squadron, Hickam AFB, Hawaii.**

Telemetry ships—**Pvt. Joe E. Mann; Kings County.**

Sea Recovery—**Haiti Victory; Dalton Victory.**

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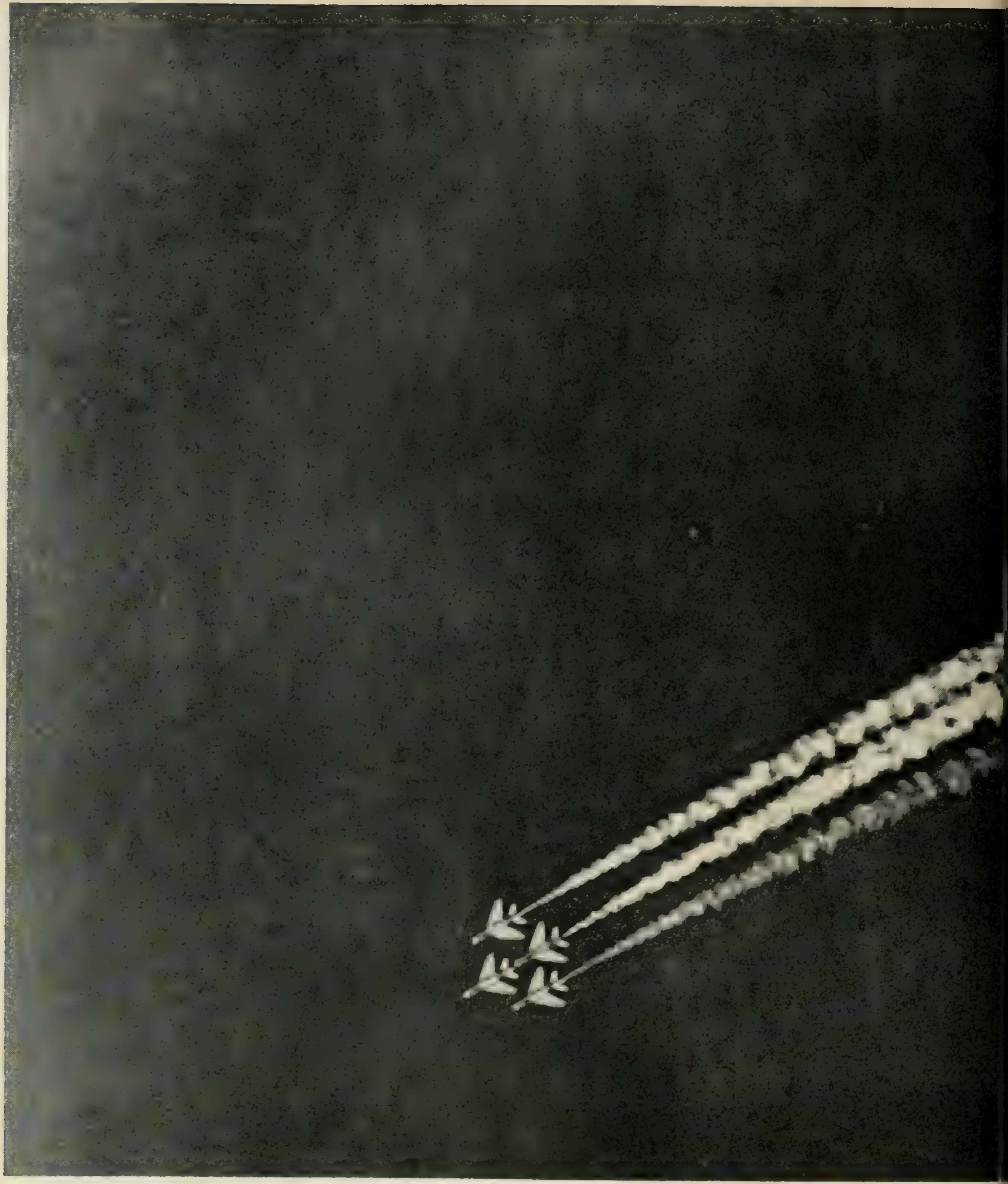
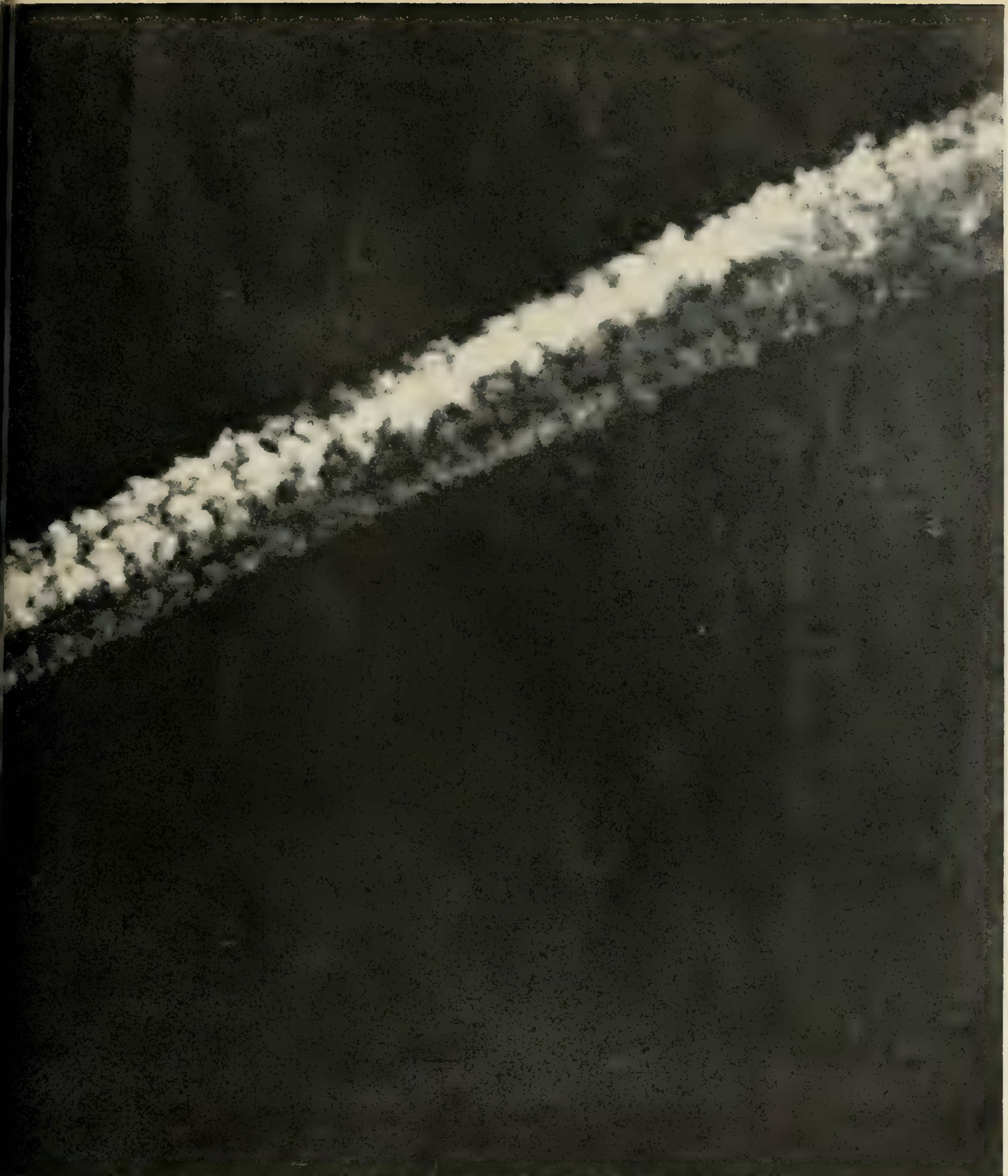


electrical energy for the needs of motion

While the prime moving forces change as ma
moves his vehicles from the highway to the sk
and on into space, the all-important auxiliary powe
continues to be electricity. Jet, rocket and missil
contractors who are in need of reliable units fo
the accurate release, transformation and contr
of vital electric energy can turn to Delco-Rem
for certain on-time delivery, whether the quantit
be measured in tens or ten thousands.



Thiokol Details Continous Solids Mix

by Jay Holmes

MARSHALL, TEX.—Thiokol Chemical Corp. last week unveiled a continuous solid-propellant mixing process it said is capable of on-site loading of rockets weighing up to 10,000,000 lbs.

The process was developed at Longhorn Ordnance Works, which Thiokol operates for the Army near this East Texas city. Army Ordnance Missile Command this month approved a 120-day funding for final statistical checking of the process to qualify it for operational use. The cost of development to date has been about $600,000.

Apparently, the continuous mixing process will become operational this summer, about the same time the Army prepares to start producing motors for the 500-mile-range *Pershing* divisional artillery missile at Longhorn.

Thiokol has worked on continuous mixing for about three years and at an intensive rate for a year and a half. At a pilot facility here, live propellant was poured for the first time Feb. 12 into an M7 *Honest John* spin rocket. A week later, a different formulation was run through and poured into an M58, 6000-lb.-thrust *Falcon* motor. At a classified demonstration for 60 representatives of the military and prime contractors on March 30, dummy propellant was poured into the case of an XM10 *Lacrosse* motor. The pilot plant has a capacity of 1200 lbs. an hour.

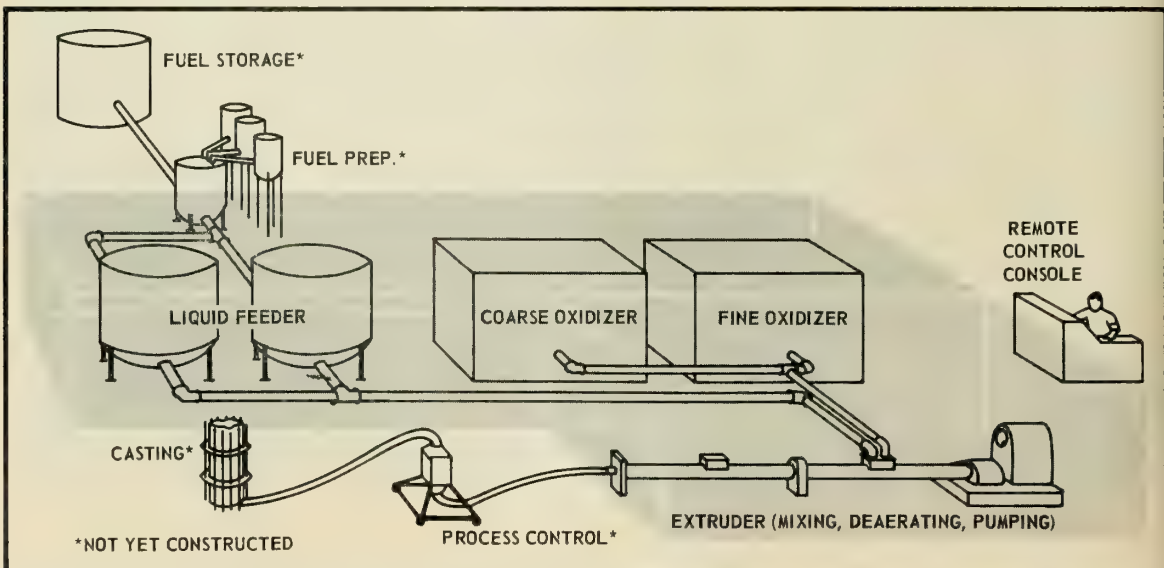
• **Extra advantages**—Everyone in the solid propellant business agrees that continuous mixing saves money, reduces hazards and improves quality control. "In mass production, the savings could pay back the cost of development within a year," says R. A. McElvogue, general manager of Thiokol's Longhorn Division.

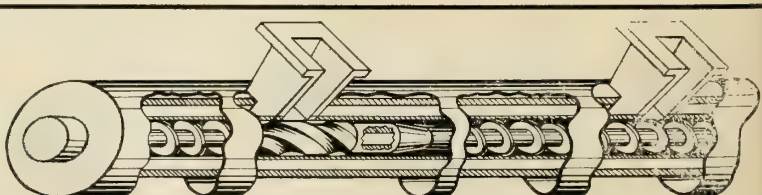
"But we see two additional advantages of continuous mixing," McElvogue adds. "First, it improves our ability to utilize high-energy propellants that are being developed. Second, it makes possible on-site loading of very large booster rockets."

Dr. H. W. Ritchey, Thiokol vice president, rocket operations, declared that continuous mixing is the key to an almost limitless expansion of solid rocket production.

• **Implications for 3059**—Although the process was developed under Army auspices, its announcement had significance in the spirited competition for the contract to develop the Air Force's Project 3059 booster of 100 million pound-seconds total impulse.

The six competitors have divided on how they would go about building such a huge rocket, which will be too large to transport from factory to launch site by rail or truck. Three companies—Aerojet-General, Grand





CONTINUOUS PROCESS developed at Longhorn Ordnance Works will start from fuel storage vat at upper left, lead into building outlined in gray. Oxidizer and fuel are mixed by extruder in second room. Extruder, consisting of variable screws, is shown in detail at right.

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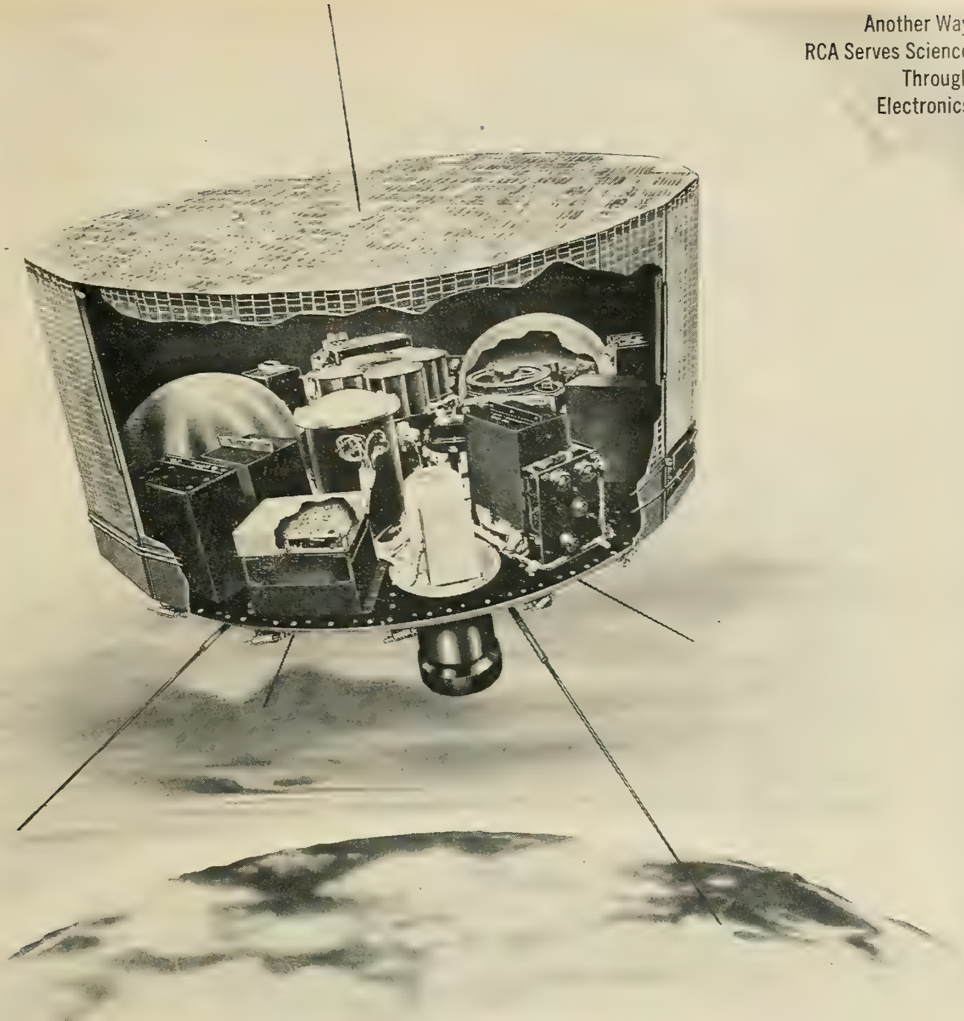

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The entire TIROS satellite, its component systems and associated ground equipments were developed and built by RCA's Astro-Electronic Products Division for the National Aeronautic and Space Administration under the technical direction of the U. S. Army Signal Research and Development Laboratory. Included in the satellite are two TV cameras equipped with shutters so they can take still pictures, tape recorders to store the pictures when out of ground station range, TV transmitters, command receivers and timing clocks for function control, radio beacons and telemetry equipment, and numerous auxiliary devices to control satellite dynamics. Power is supplied by storage batteries recharged by an array of 9200 solar cells which convert the sun's energy into electricity.

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process cost Army $600,000 . . .

Central and United Technology Corp. —proposed to overcome this difficulty by casting and constructing the big rocket in segments, which would be assembled on the site.

Thiokol and Rocketdyne, however, proposed on-site loading. It could not be learned which approach was favored by the sixth competitor, Hercules Powder Co.

Both Rocketdyne and Aerojet also are developing continuous processing methods. Rocketdyne announced the concept, which it calls "Quickmix" last fall. The Navy reported the Aerojet work earlier this month.

• **Segmenting background**—Bryce Wilhite, technical director at Thiokol's Rocket Operations Center, Ogden, Utah, said Thiokol had established eight years ago, during work on the *Loki* missile propulsion system, that segmented casting was feasible. The *Loki* was built in 1952 in two segments: a cylindrical portion and a head end. He said further studies conducted in 1956 proved that several cylindrical segments could be used to build larger rockets. A rocket measuring 6 ft. in diameter was cast in a segmented case and static-tested in 1956, he added.

However, for rockets in the 2,000,-000-lb. weight class, Wilhite said, the problems associated with handling each segment as a separate rocket and insulating and protecting the joint surfaces seemed to indicate that on-site loading would be more favorable.

• **Mating to come**—Ritchey said Thiokol is developing a portable on-site manufacturing plant, which is scheduled to become operational in mid-1961. The facility will be built around the continuous mixing process developed at Longhorn.

Actually, a completely continuous process is envisioned for casting on site. Nearing completion as components of the system are automatic in-process control, casting techniques and continuous pre-preparation of propellant ingredients.

The continuous mix pilot facility is in Longhorn's Bldg. 68G, a reinforced concrete three-room structure amid scrub pines in a remote section of the 855-acre reservation.

Propellant ingredients are fed into the machinery in one large room. The actual mixing takes place in a second large room. These two rooms are separated by a heavy concrete wall to protect equipment in the feeding room in the event of fire or explosion.

The process is controlled from a console room at one end of the structure. A sandbagged wall separates the console room from the operations rooms. No one is in the operation rooms during mixing. It is not considered hazardous for control personnel to be in the console room because only a very small amount of propellant is in the mixing machinery at any given time.

William E. Gravlee, process development engineer, explained that fuel, oxidizer and metal powder are loaded into the large feeds in batches at present, while the process is being developed. Soon, however, the material will be piped into the feed room automatically from remote storage facilities. Inside equipment consists of Omega-feeders bought from the Omega Division of BIF Industries.

• **Fourth feeder?**—At present, there are two solid hoppers and one liquid feeder. If the facility is set up to handle polybutadiene acrylic acid (PBAA) propellant, a fourth feeder will be installed. Polysulfide fuel and aluminum powder are mixed before arriving at the mixing room. A small rotary feed may be necessary for pre-mixing fuel.

The heart of the process is the mixing bay, a long cylindrical extruder containing a screw with three stages of threading. Fuel mix, a liquid, and oxidizer, a mixture of ground and unground solid crystalline matter, feed by pipes through the concrete wall.

The mixer, a modified rubber extruder, was built at Thiokol specifications by the Modern Plastics Co. Mixing takes place in the first stage of the screw, which gradually compresses material. The bore provides a back-feed that improves the mix. The mixed material then passes through a seal into a shallow-thread vacuum stage that removes tiny air bubbles that could constitute imperfections in the grain structure. After passing through another seal, the third stage pumps the mixed material into a rocket motor.

"We never doubted we could mix with this machinery," Gravlee said. "The question was whether we could mix to specification."

Doubts on this score were removed, he said, when statistical studies were made of the static-firings of the first two live runs. Ballistic data from these runs fell just outside military requirements. This means that with a very slight improvement of quality control—what amounts to a final trim of the process—the product can be brought within the standards for operational motors.

• **Simple expansion**—Development work during the final four months will concentrate on testing the system with other propellant formulations and expanding it at front and back to make it completely continuous.

For a different formulation, it is merely necessary to change the screw. Different taperings are required to allow for different feed rates for ingredients.

Expanding the system at the front is also relatively simple. It will require the installation of automatic feeders and connection with oxidizer grinders and fuel mixers. This equipment will be separate from the main mixer building.

At the rear of the system, the mix is to be led into a process control. Work on this component is moving rapidly, Gravlee said. The mix will be sampled and checked chemically, by X-ray fluorescence and by nuclear spin resonance. The slightest deviation of the product from specifications will actuate a feedback that will adjust ingredient feed rates.

The final step will pipe the mixed propellant slurry to the rocket case, where it will pour in and be cast.

The continuous process brings solid rocket manufacturing a long step closer to the current industrial goal of completely automatic production, untouched by the hands of fallible and mortal man.

To Hear the Roar

TINY MICROPHONE—about the size of a letter of type in this photo caption—is used to study the sound of rockets and jet engines at the Massachusetts Institute of Technology. MIT researchers, in a study sponsored by the National Aeronautics and Space Administration, have devised small instruments that add known sounds to streams of air. The microphone then picks up the sounds added because of flow instabilities. Additional basic knowledge on the nature of jet streams is expected to result from the study.

NAA Renews Orbital *X-15* Proposal

Crossfield hopes for government support; Reaction Motors engineers detail performance gains from switch in fuels

North American Aviation last week revived its proposal for an advanced version of the *X-15* rocket aircraft, eventually aimed at putting one in orbit.

Scott Crossfield, North American's chief engineering test pilot, told the national aeronautic meeting of the Society of Automotive Engineers that his company is optimistic about receiving government support.

The present *X-15* program ends this summer with the delivery of three test aircraft to the National Aeronautics and Space Administration. The first step in the new program would be the development of a Mach 10 version that could be drop-launched from a *B-52*.

The way to do this he said would be to shift to higher-energy fuels and to structural materials capable of handling higher re-entry velocities.

In another development, two engineers for Thiokol Chemical Corp., which is developing the *X-15* engine, suggested the use of an advanced *X-15* as a reliable, low-cost method of putting a man into an earth orbit.

The proposal by G. R. Cramer and H. A. Barton of Thiokol's Reaction Motors Division was made at a secret session of the SAE. However, an unclassified version of their paper was made available to MISSILES AND ROCKETS. They said the XLR-99 engine, which Reaction Motors has just delivered, could be scaled up for an orbital *X-15* with these three steps:

- Adding auxiliary droppable fuel tanks.
- Switching to a more energetic propellant combination, and
- Lifting the vehicle with a big booster rocket.

The current version of the XLR-99, which uses a LOX-ammonia propellant combination, is rated at 50,000 lbs. thrust. Assuming specific impulse of 290 seconds, 19,000-lb. propellant supply thus is able to maintain an average thrust of 50,000 lbs. for about 110 seconds.

The actual thrust performance is classified. However, Thiokol has said the engine will burn for about 90 seconds. This indicates an average thrust of about 61,000 lbs.

Cramer and Barton reported that, keeping a constant thrust-weight ratio, terminal velocity can be increased 35% by adding droppable fuel tanks.

They chose four representative higher energy propellant combinations for comparison with LOX-ammonia and examined physical and chemical compatibility requirements in relation to existing *X-15* components. In addition, the propellants were compared with LOX-ammonia on the basis of specific impulse, density impulse, thrust and thrust-weight ratio.

The four substitutions were LOX-hydrazine, LOX-hydrogen, nitrogen tetroxide-hydrazine and hydrazine-pentaborane. Their findings were:

- **LOX-hydrazine**—Substitution can be accomplished with only minor physical changes. Fuel impeller must be trimmed slightly because of higher density. To make hydrazine compatible chemically, magnesium fuel pump casting must be switched to aluminum and substitutions must be made for some elastomer materials in fuel system. Adequate cleanliness is a greater concern in fuel system than with ammonia.

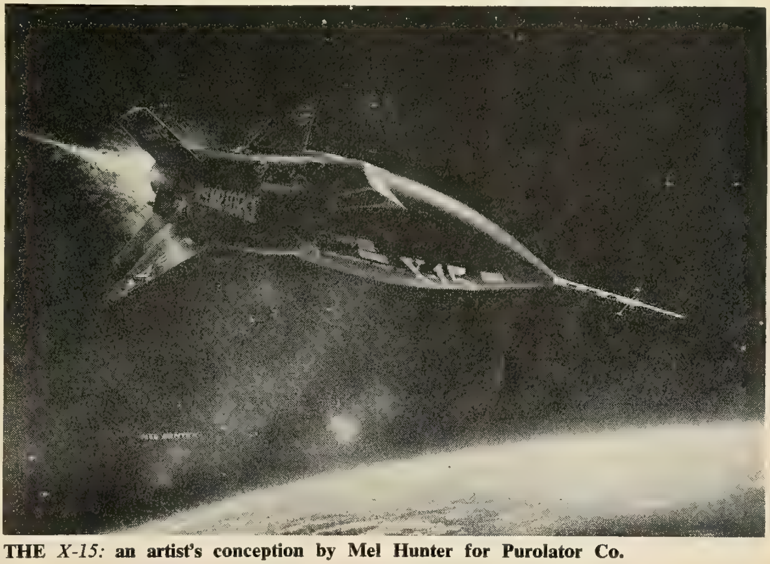
Specific impulse is increased by about 6% and density impulse rises by 27%. Since substitution can be made without changing chamber pressure, thrust and thrust-weight ratio will not change materially.

However, if propellant flow rate is increased to the full capacity of existing pumps and the thrust chamber throat is enlarged slightly without changing chamber pressure, the engine produces a thrust of almost 100,000 lbs. and thrust-weight ratio rises 46% —without sacrificing safety factors necessary for a manned vehicle.

- **LOX-hydrogen**—Low density of liquid hydrogen requires threefold increase in pump volumetric flow capacity but the low viscosity enables this to be accomplished with pressure drops actually lower than in ammonia system. All metallic materials are chemically compatible with liquid hydrogen, but most of the elastomers would shrink and harden. Material substitutions will solve this problem.

Specific impulse is increased 38% over LOX-ammonia. Density impulse, however, falls to about half of LOX-ammonia. Thrust and thrust-weight ratio again are unchanged if chamber pressure remains the same. But if flow rates are increased and the chamber throat is enlarged slightly, the thrust level and the thrust-weight ratio can be increased 28%.

- **Nitrogen tetroxide-hydrazine**—No difficulty is encountered in adjusting the pumps for this change. Chemical compatibility requires the same changes



THE *X-15*: an artist's conception by Mel Hunter for Purolator Co.

in the fuel system outlined for LOX-hydrazine. Similar changes must be made in the oxidizer system.

Specific impulse is about the same. Density impulse increases about 30%. Thrust remains the same unless the thrust chamber throat size is increased and pumps uprated. In the latter case thrust rises to over 100,000 lbs., thrust-weight ratio climbs more than 60%.

• **Hydrazine-pentaborane**—Here the hydrazine, formerly a fuel, becomes an oxidizer—nitrogen and boron combining to form boron nitride. The same changes as outlined above are needed for hydrazine compatibility. Certain elastomers must be replaced for compatibility with the pentaborane.

Specific impulse is 19% higher than LOX-ammonia. Density impulse is 4% greater. At constant chamber pressure, thrust rises slightly, because of the lower molecular weight of exhaust products. If the pumps are uprated to full flow, thrust rises 25% and thrust-weight ratio climbs 31%.

Not all of the increased specific impulse shows up as increased thrust. The remainder in each case would result in increased burning time.

Cramer and Barton did not discuss what booster would be used to lift the system. They indicated merely that the booster would be in the thrust class of a million pounds or more.

However, they gave comparative figures for payload in orbit and terminal velocity based on a fixed gross weight and a fixed booster. Setting 100 as the figure for LOX-ammonia, they said velocity would be 119 for hydrazine-pentaborane and 139 for LOX-hydrogen. Payload would be 151 for hydrazine-pentaborane and 193 for LOX-hydrogen.

More than two years ago, North American proposed an orbital *X-15* based on the G38 *Navaho* booster (3 chambers, about 400,000 lbs. thrust, LOX-RP) and the S4 *Atlas* sustainer. Those were the engines available at the time that seemed most suited. It can be assumed that the new proposal depends on later engines for boost.

How to Propose a Research Program

by Charles N. Bernstein*

The continually increasing demands of the missile developer and user for higher and higher performance provide a tremendous incentive to the propellant and propulsion scientists. They have within their hands the capability of effecting major changes in the missile and space pictures.

In solid propellants, however, the point is rapidly being reached where current systems are attaining the performance limits set by thermodynamics. It is evident, therefore, that a new and daring scientific bag of tricks must be created in order to provide a broad spectrum of varied knowledge which will enable the propellant developer to make major jumps in performance.

The primary objective of this article is to outline a *modus operandi*, from the research management viewpoint, which will best utilize the reservoir of talent that must be exploited for solid propellant investigations. Some of the general conclusions will apply equally to the liquid area.

Despite the urgency of the current situation, the scheduling of research, in the narrow sense of the word, is unrealistic. Granting hunting licenses for areas likely to contain the more attractive "varmints" is certainly one way to do the job; but how can we be sure that some unpredicted creature is not lurking in a place nobody had the foresight to explore?

The only safe procedure is to make the ability to perform imaginative research your prime criterion in selecting a group to do the job.

The person in a position to make the necessary decisions is literally being bombarded with proposals and ideas. It is obviously impossible—and in fact undesirable—to sponsor more than a small fraction of them. How, then, does one select the most fruitful avenues to pursue and the best organizations to support?

• **Criteria**—First, the reputation, background and record of accomplishment of the organization must, of course, be taken into consideration. It is not necessary that all of this background be in the relatively limited area of solid propellants. A great deal of the technology and know-how developed primarily for liquid propellant systems is now directly translatable to solution of associated problems in the solid area.

The second criterion relates to research goals. Can the proposer define the objective he is trying to reach? Even in the purest of research programs, the investigator should be able to describe, in at least general terms, what he is trying to do even if it has no relationship to any practical application. Looking at the other side of the coin, be suspicious of the research proposal that provides in the minutest detail all of the steps leading to the stated goal and almost guarantees results.

The third criterion can best be answered by asking the question, "What are the consequences of success?" Recognizing that most research proposals offer a potential promise of providing something different from what now exists, this does not necessarily mean that any improvement will be accomplished. However, research enthusiasm is a God-given attribute that we must catch at its crest and direct into useful channels.

In evaluating a research proposal, the reviewer's intuition and experience are very useful but not enough.

• **Uncertainties**—Unfortunately, it is not always possible to perform calculations which unequivocally demonstrate the value of the particular approach. This deficiency stems in part from important gaps that still exist in available thermodynamic data. A somewhat different area of uncertainty derives from the fact that performance of a new ingredient is usually calculated on the basis of a composition in which the other ingredients are known or postulated. The new ingredient, however, may be optimum in a composition which has not yet been dreamed up. In spite of these problems, it is still possible to recognize the interesting areas to pursue.

Although advanced research and high performance have been emphasized in this discussion, there are many other propellant problems that require solution. A number of these are in development, design and engineering. For such problems, competence and background of an organization are a dominating factor in contract award. The rocket groups obviously occupy a strong position because of their great experience.

The main intent of this presentation has been to show that talent should be used wherever it exists and that great care should be taken in selecting projects for support that meet the criteria of organization reputation, defined research goals and the consequences of success. It must be recognized, however, that research always involves capital risk and that it is impossible to guarantee results.

**Charles N. Bernstein is a group scientist, propellants and polymers research, with Rocketdyne Division, North American Aviation. He was formerly head of the Supporting Research Section, Surface Weapons Propulsion Branch, Navy Bureau of Ordnance.*

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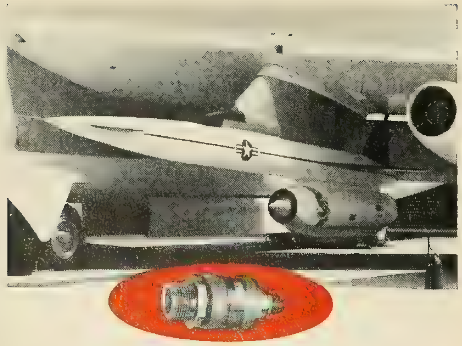

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Market Opening for Beryllium Sheet

by Rebecca H. Sparling*

Beryllium sheet has a big future in missile structures, Convair/Pomona materials researchers feel on the basis of test results.

Beryllium has a weight only 25% that of steel but 140% of steel's stiffness. Since stiffness is just as important as strength in many designs, particularly those involving sheet metal, the lighter metal is a natural candidate for missile use.

One calculation has showed that if a short-range ballistic missile made of steel, with a weight at launching of 4000 lbs., were re-designed for beryllium, the weight would drop to 3500 lbs.—a 12½% reduction—and the range would increase 60%.

But there are several problems facing designers who want to use beryllium. First, not much metal has been available for test and evaluation. Until very recently, beryllium has been used primarily by the Atomic Energy Commission for purposes other than structural, and chiefly in the form of blocks. Second, missile engineers want sheet for maximum efficiency and minimum weight—and beryllium sheet was not even considered possible until 1959. Third, more mechanical property data on the effect of temperature, strain rate, direction of rolling, and other variables, must be available before parts can be designed with any degree of confidence.

Another disadvantage to beryllium is the $100 per pound cost for sheet. But there are still some applications where usage is practical, even at this price.

To learn more about beryllium, Convair/Pomona materials research sponsored a test program on beryllium sheet supplied by the Air Materiel Command. Answers were sought to the following questions:

- Does beryllium have a good strength/weight ratio above room temperature, when heated and loaded rapidly?
- Is the high modulus of elasticity quoted for beryllium affected by the direction of rolling?
- How bad is beryllium's poor ductility?

Low ductility is a major worry in missile design. Interceptor-type missiles encounter very rapid loads in service, which encourage brittle failures even in metals which are usually ductile. Also, missiles are liable to be bumped during shipping, or in normal shop handling. A really brittle material will have limited usefulness for missile structures, no matter how good it looks on paper. We investigated this low ductility very carefully.

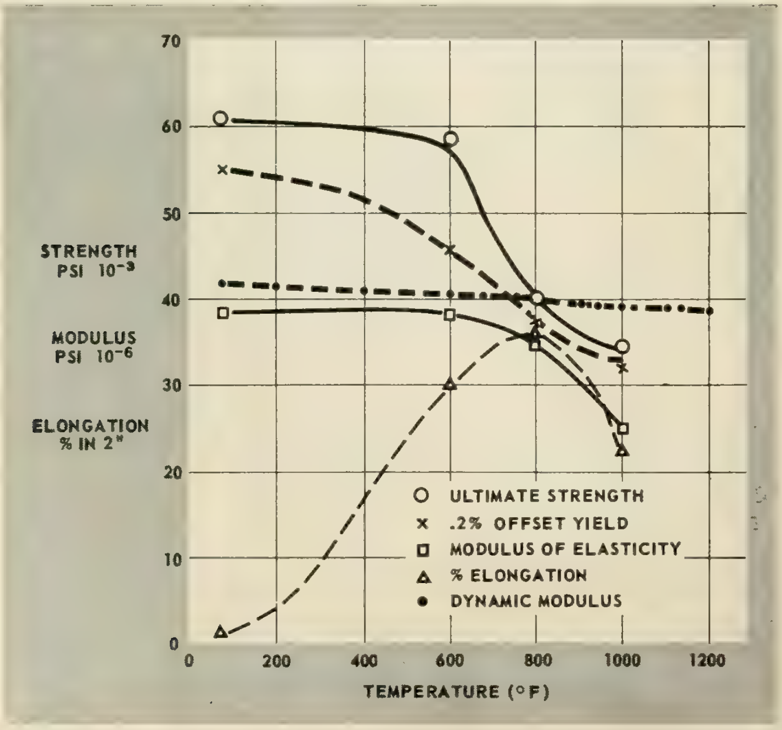
The test program included some fifty-odd coupons from beryllium sheet 0.040 in. thick, tested at strain rates from

Table I Tensile Properties of Beryllium Sheet*

Temperature, °F		Yield 1,000 psi	Ultimate 1,000 psi	Elong. % in 2"	Modulus 10^6 psi
R.T.	MAXIMUM	60.6	73.5	2.5	41.0
	MINIMUM	50.8	50.8	0.2	34.9
	**AVG. OF 9 COUPONS	55.0	60.0	1.0	38.0
600	MAXIMUM	49.6	64.8	34.0	41.0
	MINIMUM	42.9	53.0	25.0	35.3
	AVG. OF 8 COUPONS	46.0	58.3	29.9	39.2
800	MAXIMUM	43.3	48.0	51.0	37.4
	MINIMUM	35.1	36.8	27.5	28.8
	AVG. OF 15 COUPONS	38.1	40.1	36.3	34.1
1,000	MAXIMUM	37.3	38.1	32.0	33.8
	MINIMUM	29.2	29.4	17.5	17.7
	AVG. OF 12 COUPONS	33.1	33.6	22.4	24.1

* Only etched coupons included.
** 7 unetched coupons gave comparable average but wide range.

Beryllium Sheet Strength Characteristics



*Mrs. Rebecca H. Sparling is staff consultant for materials at the Convair Division of General Dynamics Corp. Pomona, Calif.

0.004 in./in./min. to 0.20 in./in./min. Test temperatures were 80°, 600°, 800° and 1000°F. with coupons heated at a rate of about 200° a second, to simulate aerodynamic heating during flight. Dynamic modulus tests were also made from room temperature through 1200° F. The results (shown in Figure 1 and Table 1) answered our questions in the affirmative.

The good strength/weight ratio of beryllium is maintained up to 1000°. The modulus is high in both the longitudinal and transverse directions. The low ductility at room temperature will probably be a problem in design, but it is not severe enough to cause breakage from normal handling. It is no worse under rapid loading. At 600° and above, there is enough elongation to permit forming parts.

Here are details of the test results:

• **Strength/Weight Ratio**—Beryllium's strength/weight ratio is excellent. It is as good as, and sometimes better than, semi-austenitic precipitation hardening steels up to 1000°F. Furthermore, we think that the agreement between coupons was exceptionally good for such a new material, and for one of the first attempts to roll beryllium into sheet. As other work on extra-pure beryllium, and new alloys of beryllium, gets under way, no doubt the strength will be increased appreciably.

Table I lists the maximum, minimum and average values for 0.2% offset yield strength, tensile ultimate, % elongation at fracture, and the modulus of elasticity. Four coupons which broke in the grips before loading, or had obvious defects in the material as one did, were not reported.

• **Modulus of Elasticity**—No effect of directionality was observed. The longitudinal coupons tested at room temperature were slightly stronger than the transverse ones, but the difference was so small that no conclusions can be drawn. At other temperatures, the direction had no significance at all. The modulus was not affected by direction at any temperature.

The results of the dynamic modulus tests are listed in Table II. The dynamic modulus does not decrease nearly so fast with rising temperature as the static modulus, no doubt due to

Table II Effect of Temperature on Dynamic Modulus of Beryllium

Temperature °F	Dynamic Modulus 10^6 psi
75	42.1
200	42.0
400	41.8
600	41.3
800	40.5
1,000	39.6
1,200	38.5

Table III Strain Rate Effect on Beryllium

Temperature °F	Strain Rate in/in/min.	Yield Relative Standing	Yield 10^3 psi	Ultimate 10^3 psi	Elong. % in 2″	Modulus 10^6 psi
R.T.	Max. .204	1 of 9	60.6	73.5	2.5	39.1
	Min. .004	3 of 9	55.2	65.8	2.0	37.0
600	Max. .186	2 of 8	48.7	64.4	25.0	38.3
	Max. .186	8 of 8	42.9	56.5	34.0	39.0
	Min. .004	1 of 8	49.6	64.8	27.0	41.0
800	Max. .075	10 of 15	36.9	38.9	38.5	28.8
	Min. .004	6 of 15	38.1	38.9	BOM	35.3
1,000	Max. .096	4 of 12	34.4	34.8	19.0	17.7
	*Min. .020	8 of 12	32.6	33.4	28.0	18.5
	Next to slowest .050	5 of 12	33.7	34.1	BOM	31.8

* The slow rate could not be maintained because the coupon crept so much.

the creep which is present in high-temperature tensile tests. The coupons in the dynamic modulus tests were not loaded, but vibrated at their resonant frequencies without any load.

• **Strain-Rate Sensitivity**—From our tests, it does not appear that beryllium is sensitive to changes in strain rate. At room temperature, the two strongest coupons were those pulled at the fastest strain rate, but there was no correlation between strain rate and strength among the other seven coupons pulled at room temperature, nor among those tested at elevated temperatures. Table III points this out.

Although the slow strain rate of 0.004 in./in./min. could be maintained without trouble at 600 and 800°, the beryllium started to creep so fast under load at 1000° that we had to increase the strain rate. The coupon listed as pulled at 0.020 in./in./min. at 1000° actually strained at a much higher rate after yield. For that reason, the second slowest coupon tested at 1000° is also included, with the thought that the 0.020 in. strain rate might not be representative.

In an effort to evaluate the effect of strain rate, we chose the relative standing in yield strength as the criterion. The highest yield strength at each temperature would be 1, the next highest 2, and so on. We also checked the relationship, if any, between strain rate and modulus, and strain rate and elongation. The conclusion is that beryllium is not affected by changes in strain rate within the limits of our tests.

• **Ductility**—The ductility of beryllium, as measured by elongation after fracture, was poor at room temperature, good at 600° and 800°, and dropped off again at 1000°. But elongation is not an adequate measure of the ductility of sheet. We also checked the reduction of width of the coupons at the point of fracture; however, these values correlated very closely with the elongation. Another way to estimate ductility is by the difference between the 0.2% offset yield strength and the tensile ultimate strength. These figures, listed in Table IV, again emphasize the superiority of 600° so far as ductility goes. We think this may be the optimum temperature for hot forming beryllium parts.

Table IV Difference Between Yield and Ultimate

Temperature °F.	Difference 10^3 Psi Max.	Min.	Av.
75	13.8	0	5.7
600	15.7	9.4	11.1
800	4.7	0	2.2
1,000	0.8	0.2	0.5

• **Future use**—In spite of low ductility, high cost, and necessary health precautions, beryllium has a bright future for missiles and aerospace vehicles. No other structural metal offers such high stiffness with such low weight. In the short time that work has proceeded on rolling beryllium sheet, enormous strides have been made. The improvements resulting from present programs on high-purity, alloys, zone-melting, etc. will no doubt improve the mechanical properties of this attractive metal. And with increased usage will come lower cost.

So much has been said about the very high temperatures encountered by missiles, that we sometimes neglect all the parts which are not hot! For such applications, beryllium will help missile designers reduce weight and improve performance.

Raincoat Process Applied To Mixing of Solid Fuels

A process developed in World War II for production of vinyl raincoats now is used for mixing solid propellant.

Atlantic Research Corp. uses the technique in obtaining the desired rubbery consistency in its polyvinyl chloride-based propellant. Union Carbide Corp. developed the process which uses a plastisol.

A plastisol is a dispersion of vinyl resin particles in a plasticiser. The mixture fuses into a tough, rubbery material when heated to about 350°F. In the solid-propellant formulation, the resin and plasticiser is mixed with aluminum powder and ammonium perchlorate. The perchlorate is the oxidizer and aluminum increases the temperature of the flame, thus increasing the specific impulse.

In the Atlantic Research process, the four ingredients are mixed into a mud-like slurry. The plastics used are

POURING polyvinyl chloride-based propellant at Atlantic Research Corp.

based on Bakelite vinyl chloride resins produced by Union Carbide. The raw mix is poured into a mold that is steam-heated through the outer jacket and usually the inner mandrel.

After heating, water cools the grain and it is trimmed before loading into the rocket case.

Atlantic Research propellant powers such rockets as the *Arcon* and *Arcas*, high-altitude sounding rockets, and the *PET* (propellant, experimental test), which performs spin and retro functions on larger rockets. Since all of these are relatively small, Atlantic Research spokesmen said, there has been no requirement for case-bonding. However, they say it is possible to case-bond polyvinyl chloride-based propellant.

Improved Oxidizers

Thiokol Chemical Corp. reports discovery of improved methods of producing three new nitrogen-fluorine compounds used as propellant oxidizers—dinitrogen fluoride, dinitrogen difluoride and difluoramine.

Step-Up in Materials Testing Urged

Researchers score lack of background materials design data; say early space testing is critical requirement

by William J. Coughlin

SANTA BARBARA, CALIF.—Establishment of a large-scale national program for testing space age materials in space has been called for by three members of the Lockheed Missile and Space Division.

"We have to considerably increase our knowledge of the performance of basic materials in space," they told a three-day session of the American Rocket Society here. "At the present time our knowledge of the effects of the space environment on the behavior of materials is not complete, especially when we are required to design satellite systems for reliable operation for prolonged periods of time."

The proposal for a stepped-up test program was made in a paper delivered by Morris Steinberg, J. J. Fox and Bruno Augenstein to the ARS conference on Structural Design of Space Vehicles held April 6-8. The meeting, sponsored by the Structures and Materials committee of ARS, drew more than 300 industry and government specialists from throughout the nation.

"First of all," the Lockheed personnel said, "we have to learn more about the actual environmental conditions, especially the many simultaneous environments existing in space. Secondly, we have to determine the effects of these special environments on our materials, and thirdly, we have to determine ways of improving our materials and establishing criteria by which we can select materials for appropriate jobs with confidence that these materials will operate successfully and usefully."

• **No design info**—They said the large background of information required to design high-confidence but not over-conservative systems does not yet exist. A list of some of the problem areas where further knowledge is needed included:

• Erosion of surfaces and finishes by meteoritic matter.

• Long term radiation effects on organic material such as Teflon or lubricants, or on dielectrics and solid state materials.

• Sublimation and evaporation of materials in a vacuum.

• Friction and lubrication in bearing surfaces, switching contacts and gear trains.

• Degradation of organic materials by the short-wave end of the solar spectrum.

• Permeability of thin shells such as those used in space structures rigidized by internal pressure.

• Behavior of thin films of material.

• Possible problems of sputtering of materials by incident atomic and molecular surface bombardment.

• Damage to materials by corpuscular radiation from the sun.

• Problems arising from leakage radiation produced by a nuclear source.

"It will be noted that these typical problems involve damaging effects to either electrical, mechanical or optical properties of the vehicle and its components, all of which are of significance to the vehicle operation," they said. Some, it was acknowledged, may turn out to be phantom problems.

"In any event, until we can be confident that these are phantom problems or that we can correctly design against these problems, uncertainties will exist in our ability to fully exploit the great potentialities of space systems," they declared.

To remedy the situation, an "immediate, vigorous and carefully-planned" program of ground and space research and testing was proposed. The program places heavy emphasis on testing in space.

"Although this program seems to differ, at least initially, in some ways from the ballistic missile test program, which is keyed towards ground testing . . . we expect that the majority of the test work will ultimately be done in ground tests, once the requisite knowledge, facilities and techniques are available and well established, and have been shown to be adequate," the three men said.

• **Five-point program**—The proposed five-point program calls for:

• An increased effort to obtain complete information on geophysical environments. "Much of the current scientific measurement program is perforce of a cream-skimming nature, and does not permit us to state in an unambiguous fashion that possible difficulties are phantom problems, nor does the current program in most cases give very useful design information," the Lockheed researchers charged.

• Immediate initiation of complementary ground and space testing programs for materials, with early and urgent emphasis on space testing. "Initially, because of geophysical uncertainties and because of difficulties of ground simulation, there will be an urgent requirement for space testing," it was stated. "Furthermore, many of the ground facilities are still in the planning stage and will not be available for some time . . . Consequently, there will be considerable motivation for a number of early tests to be done in space. Once we have learned more about the space environments, have developed the capability to simulate them as well as we need to, and have determined that we can test effectively in our ground laboratories without having to duplicate simultaneously all the space environments, more of the testing burden should fall to the ground laboratories."

• Consolidation of accumulated data into one source, with periodic revisions and up-dating. "Our knowledge of the geophysical environments and the response of materials to these or analogous environments, as determined in ground testing and in space testing, is scattered through a great many literature sources," it was stated. "In this form the information is not very accessible and cannot easily be brought up to date. Furthermore, the information is not often cast into a form most useful for design purposes."

• Initiation and extension of theoretical studies relating to the interaction of environments and the response of materials. "Some of these studies can tell us how to extrapolate our meager theoretical knowledge and experimental data to other situations, other studies can clarify the physical mechanisms involved in degradation of materials, and still others can help us in designing unambiguous experiments in our ground and space testing program."

• Initiation of a test program at high or extreme values of the environmetal parameters wherever such tests are possible. "Such studies can have a number of consequences," the researchers stated. "In some cases problems of measuring instrumentation could be simplified; in other cases the material response to hyper-environments would provide critical tests of a theory and would allow more confidence in the extrapolation of that theory to a variety of different situations. A most important consequence would be the possible compression of testing time in our ground laboratories, if correlations could be shown between long duration tests in a conventional environment and accelerated tests in hyper-environments."

• **Cite Lockheed's work**—To back up their proposal for a national program, the three men cited the extensive materials testing program underway at Lockheed Missile and Space Division.

Plans for construction of a large LMSD environmental facility to simulate some of the space environments are in the advanced design stage, it was disclosed.

A major LMSD program also is underway to study the stability of various temperature control coatings under combined vacuum, temperature, and ultraviolet radiation and under rapid ascent heating.

Among in-flight experiments under consideration at Lockheed are:

• A flyable package that will investigate a number of mirror materials by utilizing a point light source and a photocell or thermopile and intermittently comparing the values of the incident and reflected energy. This will be used to study rate of deterioration of mirror reflectiveness, of major interest where mirrors are used in satellite solar power packages.

• An "oriented cube" in a noon polar circular orbit to measure the sputtering process which results in the ejection of an atom, molecule or ion of a surface material when it is bombarded by an external atom, ion or molecule. It also would measure micrometeorite erosion. An oriented cubical satellite will be used since it can measure effects on sides facing only the earth and only the sun as well as the varying combinations.

• An experiment in which bearings will be operated in a special tester carried aboard a satellite, with the operating characteristics and failure times of the bearings to be telemetered to earth. Running torque of the test bearings will be indicated by strain gage transducers and the variation of the transducer output will be directly related to torque. Failure points as well as temperature readings via thermocouple signals will also be available.

Motor power consumption also will be measured. As bearing torques increase, motor power consumption can be expected to increase. When a failure point is reached, the bearing will be pulled out of the system. A sharp drop in motor power consumption should be detectable, giving a second check on the failure point of that bearing.

• Space experiments in the "not-too-far-distant" future to study a number of methods of rigidization of inflatable structures.

• **Stress composites**—Several papers stressed the use of composite materials to overcome some of the space difficulties cited by the Lockheed team. Hans Schuerch of Astro Research Corp. told the group that many undesirable side effects of certain materials may be overcome by selecting combinations of sceletal and matrix materials that exhibit different types of materials response to the particular environment for which the composite material is designed.

Emphasis placed on inflatable space vehicle structures . . .

SANTA BARBARA, CALIF.—Heavy emphasis was placed on the use of weight-saving inflatable structures for space vehicles and manned space stations at the American Rocket Society conference here.

Some of the designs for expandable structures included:

• A "link sausage" space station proposed by Emanuel Schnitzer, aeronautical research engineer at the National Aeronautics and Space Administration, Langley Research Center. The erectable interrupted torus would be carried aloft unmanned in the nose cone of a space vehicle and inflated on station. Its two-man crew would rendezvous with the space laboratory in a taxi of the Dyna-Soar type. Powerplant would be an inflatable solar energy collector, although this might be replaced by a nuclear powerplant similar to *Snap II*. The 40-ft. diameter station would spin at about six rpm to provide gravity of a quarter G force. Gross weight of the station, which would carry food and water for 60 days although designed to a minimum station life of one year, would be 15,000 lbs.

• Rocket-powered land vehicles, helicopters and aircraft for surface exploration of Mars, suggested by Rand Corp. engineer Francis T. Cartaino. Powerplants would be rocket turbines consisting of a fuel and oxidizer source, a combustion chamber similar to a rocket motor, a multistage turbine and a reduction gear. Cab of the Martian truck would be of lightweight pneumatic construction consisting basically of rubber impregnated fabric similar to that used in the Goodyear Inflatoplane. Body and rotor blades of the helicopter would be of inflatable construction with the landing gear, powerplant and fuel tanks the only major metal components. This also would be true of the proposed airplane, a twin-engine high-wing monoplane similar to present-day aircraft. It would be equipped with rough field fixed landing gear and cruise at 180 knots. The rocket engines would drive unusually large propellers due to the low atmospheric density, equivalent at Mars' surface level to about 55,000 ft. earth altitude, but otherwise the aircraft would appear almost conventional.

• A space station converted from the empty fuel tanks of the final stage booster. This was proposed by NASA's Kurt Stehling, who said space available in the tankage could be supplemented by inflatable structures, probably of a fiberglas reinforced plastic or neoprene sealed fabric.

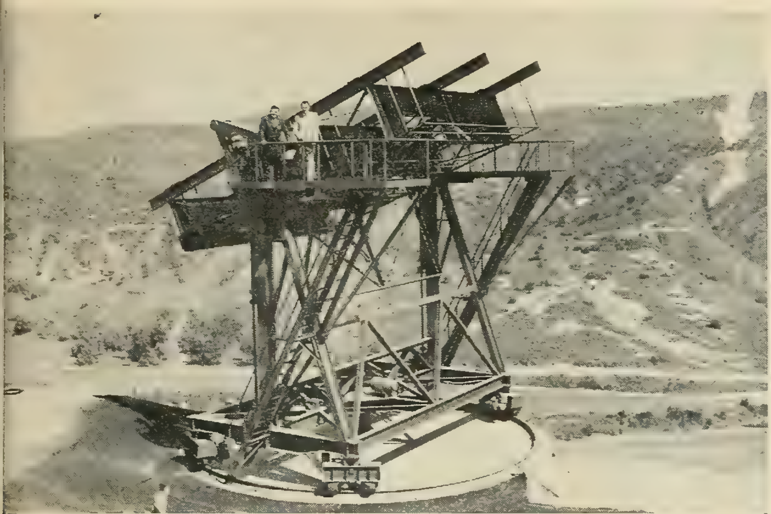
• A two-man inflatable space station with a usable volume of 5000 cu. ft. for a structural weight of 2600 lb., proposed by Goodyear Aircraft Corp.'s Frank B. Sandgren and James T. Harris. Total station weight would be 6000 lb., including life support, laboratory and communications equipment; solar power converters; and food and medical supplies for six days. Boost package would be a filament wound rigid fiberglass cylinders 10 ft. in diameter and 28 ft. long, weighing an estimated 1000 lb. This would become a zero gravity laboratory forming the hub of the inflated torus. The fabric torus would provide living quarters 30 ft. in outside diameter with a seven ft. diameter cross section. Sandgren said such an inflated structure would provide ample safety at far less weight than a rigid structure. The structure could be "rigidized" by blowing quick-setting plastic foam between the walls or by use of castable neutron shielding materials. The Goodyear engineers also suggested that a 14-man expandable station could be packed into a compartment 10 ft. in diameter and 40 ft. in length, the space available in the final stage of the *Saturn*.

Among the non-inflatable designs discussed at the meeting were:

• A non-recoverable three-man 14-day orbiting scientific laboratory of aluminum sandwich construction proposed by J. W. Bilodeau and D. M. While of the Astronautics Division of Chance Vought Aircraft, Inc. The system includes an entry vehicle design to transport occupants to and from the orbiting station. Combined weight of the laboratory and entry vehicle is approximately 15,000 lb., limiting boosters to the *Saturn* class. The Chance Vought engineers said, however, that use of the modular concept in contrast with one integrating the laboratory with the entry vehicle showed a 20-30% weight saving.

• A winged and recoverable rocket booster on which Convair Astronautics has carried out preliminary design studies under an Air Research and Development Command contract. These studies indicate a first stage winged booster will be about 60% greater in size and weight than conventional boosters.

mergers and expansions



This huge rotatable antenna mount is part of Hughes Aircraft Co.'s new $225,000 advanced radar test center just put into operation near Yorba Linda, Calif. The mount can handle an antenna weighing up to 25 tons, turn a full 360 degrees, and tilt up to 90 degrees. It will be used in testing advanced military antennas in conjunction with a transmitter site (arrow) 4000 feet away on the other side of the canyon.

MISSILE R&D FIRM FOUNDED: Unified Science Associates has established facilities for basic research and development in Pasadena. The independent firm will conduct basic R&D in propulsion, cryogenics, data storage, heat transfer, optics and infrared.

Dr. S. Naiditch, formerly with Electro-Optical Systems, Inc., is president of the new company. Members of the scientific staff include Dr. Stuart Fisher, previously with Space Technology Laboratories, and Dr. Phil Taylor, formerly with Aerojet-General.

CLARY SELLS DIVISION: The Clary Corporation, designer and manufacturer of electronic computers, data handling equipment, and mechanisms for guidance and propulsion systems used in missile programs, has sold its adding machine and cash register division to Remington Rand Division of Sperry Rand Corp.

WALTHAM ACQUIRES ELECTRO-MEC: Waltham Precision Instrument Co.'s sales are expected to be increased 50% by the acquisition of Electro-Mec Laboratory, Inc., of Long Island City, N.Y.

GOODRICH PLANT TO TRIPLE: B. F. Goodrich Co.'s rocket motor plant in Rialto, Calif., will be expanded to three times its present size. Facilities under construction include an office building, R&D area, and production equipment.

LITTON EXPANDS IN CANADA: Litton Industries has acquired the Canadian subsidiary of Servomechanisms, Inc. (Servomechanisms, Ltd.) in a recent cash transaction. Already specializing in development and production of equipment for airborne electronic and electromechanical instrumentation, the Canadian operation will be expanded with emphasis on advanced electronic products including inertial guidance systems for the RCAF Lockheed CF-104.

SIEGLER MERGES: Siegler Corp. stock is being exchanged for three and one-half shares of Magnetic Amplifiers stock.

SYSTEMS OPERATION FOR GT&E: A Systems Engineering and Management Operation has been established within Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc. The new operation will represent GT&E in all activities relating to large military systems contracts, with headquarters in Needham, Mass.

PEARCE-SIMPSON EXPANDS: The Miami electronics manufacturer has established a Molded Plastics Division. The plant was formerly known as the Varney Plastics Co.

ESCO BUYS ELECTRO: The Electro Switch Corporation of Weymouth, Mass., has purchased the assets of Electro Contacts, Inc., Osterville, Mass.

PSI MOVES: Reliability functions of Pacific Semiconductors, Inc. have moved to large new quarters in Hawthorne, Calif. PSI produces micro-miniature diodes, transistors and other semiconductor devices.

ALLIED RESEARCH DIVIDED: Allied Research Associates has formed two divisions, Research and Engineering. Daniel J. Fink will lead the former and Roger S. Warner the latter.

financial news

Teleflex, Ltd.—Net sales climbed 52% to a record $6.2 million from $4 million in 1958. Earnings jumped 73% over the '58 figure, from $151,362 to $262,273. The company succeeded somewhat in decreasing its dependence on sales of control systems for military aircraft, which accounted for 48% of total sales in 1959, as opposed to 62% in 1958 and 76% in 1957.

• **Motorola Corp.**—Motorola broke two company records with an increase of sales of 33% and earnings 92% over 1958. Fourth quarter sales of $83.5 million were also high for the period, and earnings of $4.69 million the highest since 1950. Total 1959 earnings were $289.5 million.

• **Borg-Warner**—Sales for 1959 hit an all-time high of $469.9 million—an increase of 21.9% over 1958.

• **IT&T**—International Telephone and Telegraph Corp. showed a record year for sales and revenue. Total sum was $765.6 million or 11% over 1958.

• **Hazeltine Corp.**—Gross income including royalties declined from the 1958 peacetime peak of $62 million to $55 million, due in part to 1959 being a heavy development year. Net income rose almost 21%.

• **American Electronics**—American Electronics, Inc., reported net earnings of $609,599 for 1959 as compared to a net loss of $2.3 million in 1958. Net sales totaled $25 million, a 44% increase over the $17 million registered in 1958.

• **Republic Aviation Corp.**—Republic reports sales of $198 million with profits after taxes of $3.4 million, a drop from 1958 net sales of $218 million and net income of $5.1 million. Backlog at beginning of 1960 was $511 million.

Soviets Optimistic on Space Flight

Unlike most U.S. scientists, Russians minimize hazards other than re-entry, which they expect to solve soon

by Dr. Victor P. Petrov*

Recent Russian publications indicate a difference of opinion between U.S. and Russian scientists as to how soon man will be able to undertake meaningful space flights.

Most U.S. scientists prominent in the study of space flight have predicted that extended flights into space will be extremely hazardous because of cosmic radiation and related solar activity. A sudden flare-up in this activity, according to many of them, could quickly disintegrate the space ship.

The published writings of Soviet scientists in this area do not agree with these gloomy predictions. The Russian scientist B. S. Danilin, in a recent article, stated that according to data received from the Soviet *Luniks*, extended space flights are possible, that at present it is feasible to map out the existing problems quite accurately.

The main problem, Danilin said, is to return the astronaut safely to earth. Most of the other problems connected with space flight have been studied thoroughly and apparently can be dealt with even with our present knowledge, he said, except for the problem of re-entry.

• **Dogs & rabbits**—Danilin stated that Soviet experiments have shown that animals can withstand extreme acceleration and radiation, apparently without any harmful effect. These tests were conducted with several dogs and rabbits some of whose names are now history.

The first visible indication of Soviet space flight research in August, 1958, when Russian scientists sent a rocket to an altitude of 280 miles with two dogs.

In addition to the dogs was a bank of scientific instruments weighing 3726 pounds. Soviet scientists claimed at the time that this was the first time that a one-stage rocket, carrying a load of over 1½ tons, rose to such a height and returned to earth intact, bringing back alive and unharmed the animals it carried into space. They also claimed that the shot marked the first use of a new guidance system which caused the rocket to land at a pre-determined location. This guidance system has, undoubtedly, been further improved; perhaps we were recently witnessing its performance when the Soviets sent their long-range missiles into the Pacific Ocean areas, attracting world-wide attention.

Information on the results of Soviet biological experiments is gradually becoming available. As we already know, dogs were launched in rockets in two ways: in hermetically sealed compartments, and in special flight suits with oxygen helmets. Fourteen dogs were used for experimental flights to various altitudes in hermetically sealed compartments; these dogs weighed from 5 to 7 kilograms. Experiments with dogs in special flight suits and helmets were conducted with 12 smaller animals, weighing on the average 4 to 5 kilograms. Some dogs made two and even three trips into space.

• **Weightlessness harmless**—Another problem to cope with was weightlessness in space. Again, several flights of dogs and one rabbit, by name Marfushka—and especially the protracted flight of Laika in *Sputnik II*—proved that animals easily endure the state of weightlessness. The main lesson learned from the Laika experiment was "that the animal was not harmed by acceleration nor by gravity-free conditions."

This was the first data ever obtained on the effect of weightlessness upon an organism over an extended period. It provided reason to believe that man also can function under gravity-free conditions.

We know that the Soviets are energetically preparing for man's travel into space. Photographs published in Soviet magazines show an airman, attired in a pressure suit, undergoing tests of his physical reactions to simulated high-altitude conditions, extreme cold, and rarified air. These test probably will lead to advanced training for actual flights. Alexander Bukulev, President of the USSR Academy of Medical Sciences, said as recently as January, 1960, that "Soviet physiologists have already obtained experimental data proving that the living organism is not seriously affected in space flight . . ."

• **Meteors likewise**—One of the problems which has occupied the minds of scientists is meteors—how real a hazard they will be for future space ships. B. S. Danilin, in his article mentioned above, says this danger was obviously exaggerated.

Up to now, not a single Soviet *Sputnik* has had a collision with a meteor of any appreciable size. Even the solar (silicon) batteries placed on the surface of *Sputnik III* were not damaged. This tremendous satellite, orbiting around earth for almost two years, still sends its radio signals by means of electric power obtained from solar batteries on its surface. The author expresses the opinion that this successful experiment means that similar solar (silicon) batteries will be used in future interplanetary flights.

• **Radioactivity minimized**—At the same time Danilin said, contrary to the opinion of American specialists, Soviet *Sputniks* and *Luniks* have definitely lessened fears of the effects of cosmic radioactivity on living organisms. Proper protective clothing and correct selection of launching sites for space ships would, he declared, preclude the possibility of astronauts being affected by radioactivity.

More information is necessary before man embarks on his first space flight, Danilin admitted—more accurate information and data on the density of air at high altitudes, the degree of ionization of the earth's atmosphere, the intensity and power of cosmic rays, meteoric danger, were the major areas he listed. All these data are needed, according to the Russian scientist, for calculating the lines of radio communication for plotting rocket or satellite flights, and finally for determining the take-off and landing sites of space ships.

• **Matter of fact**—The latest exploits of *Luniks*, he said, clarified to some extent the question of whether or not the space between planets is

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void of any matter. It is not an absolute vacuum, as it was previously thought. Even *Lunik I,* which went into orbit around the Sun disclosed according to the Russians, that at a distance of 1500 kilometers from the earth's surface there are about 1000 protons per cubic centimeter of space, and even at an altitude of 110,000 or 150,000 kilometers there are from 300 to 400 positively charged particles per cubic centimeter.

Another thing, proved by *Lunik I,* the Soviets say, is that the meteoric matter in space consists of very small particles. They are not solid rock or metal but rather friable matter, something resembling snowflakes or flakes of soot. The contact of the rocket's surface with meteoric particles the size of about one billionth part of a gram occurs once in several hours, while contact with larger bodies is practically nonexistent.

• **Re-entry remains**—Therefore, according to Soviet scientists, the only real problem is the question of re-entry. With the present level of knowledge, a rocket travelling with enormous speed will enter the atmosphere and will melt or disintegrate, as a result of friction. It will be necessary to find means of effectively cooling the body of a spaceship and retarding its speed, possibly by means of a specially designed medium combining aerodynamic and ballistic principles.

Until this problem is solved, it will be premature to talk about timetables of man's flight into space. However, the scientist concluded that he has no doubts that "Soviet people will eventually solve this problem and shall witness our country's new brilliant achievements in conquering cosmic space."

Soviet scientist E. K. Fedorov's theory on return landings states that spaceships will be braked either with the aid of jet engines, which will require enormous amounts of fuel, or by gliding. The latter would be done by diving into the dense atmosphere and then ascending again so as to lose heat resulting from friction in the denser atmosphere. An article in the Soviet Department of Defense newspaper proposed a similar gliding process,—i.e. diving and ascending, and then repeating the process.

• **Lots of confidence**—There are no qualms in the writings of Soviet scientists on the subject of flights to the moon and planets. Academician J. Bardin said that "the time is not far off when the first manned rocket will start off into the space." Academician V. Fesenkov said that, "undoubtedly the flights around the moon, Mars and other planets, and even landing on them, will be possible in the nearest future."

In the same vein, Academician A. Lebedev stated that "the time will come, when similar, more perfect laboratories will fly to the moon and the nearest planets." Academician L. Sedov (the one probably most frequently quoted) also said that soon "manned space ships will be sent on interplanetary trips. . . . Undoubtedly, these flights will be preceded by interplanetary flights of 'automatic research laboratories'."

• **Moon stressed**—Since the moon is the nearest target for such flights, V. E. Yegorov said that the "next stage, apparently, will be the realization of flights to the moon. With the present know-how in rocket construction, obtaining speeds for such flights is a definite possibility." The moon, in the opinion of Soviet scientists, will be the first target for man's flight into outer space. It can be used not only for the study of this outer space body, but can also be utilized as an interplanetary station—a launching site for further explorations of the Universe.

Study of the moon, according to Yegorov, is most important to scientists who want to know the physico-geographic conditions on that natural satellite of the earth.

"We know Yegorov states that there is no water and very little if any atmosphere on the moon. We also know the range of daily temperatures, but there are still many unknown things which we would like to learn about the moon. Even before future astronauts land on the moon, we will be able to learn many things by flights of rockets similar to *Lunik III* around it; this data by means of photographs will be televised to earth."

An enormous push in the flight of imagination was provided by the first *Lunik* sent into solar orbit, passing at a comparatively short distance from the moon. Prof. B. Kukarkin, on this occasion, said that from now on the planning of interplanetary travel within our solar system becomes a goal of practical realization. Trips to Venus and Mars will be made within a few years. Prof. Yu. Pobedonostzev said that, the time is not far off, when interplanetary ships will fly to the farthermost corner of our Solar system. Mankind has entered into the era of actual penetration into the Universe. . . ."

• **Farther out**—A fantastic preview of what to expect in the future is given by B. Mirtov, who said that the next cosmic rockets will allow us to penetrate the Universe even further. We may meet there some forms of matter, whose existence we do not even suspect. He is sure that we shall be able to peek into the unknown worlds of the moon, Mars and Venus in the very near future with the aid of the television eye first.

This initial investigation will tell us if landings will be possible on these planets. Next, a manned cosmic rocket will be on the way to reveal secrets of enigmatic worlds. "And who knows . . .", he said, "perhaps these ships of the star world will find the first Soviet messenger into the Cosmos (now orbiting around the sun), and will tow it back to earth."

Inevitably the question is asked:

French Push for A-tipped Missile

by Jean-Marie Riche

PARIS—With two successful atomic explosions to their experience, France is accelerating studies for an IRBM/-ICBM with a nuclear warhead.

French atomic experts state that they now are able to produce any type of A-bomb or A-warhead the French Defense Department may order. With the appropriate financial effort, they say they are ready to undertake the development of H-weapons. Their confidence is based on the two recent successful experiments in the Sahara.

Research and development of the French ICBM/IRBM is managed by the Air Department of Defense, in cooperation with the Army, Navy and Scientific Dept. of Defense. It will be designated *SSBS* (Sol-Sol-Balistique-Strategique) and almost certainly will have a solid motor.

France's space efforts, led by the *Veronique* rocket, essentially use liquid rocket engines. An advanced model, the *Super Veronique,* is under development for spatial experiments.

The biggest problem facing French missile experts is that of re-entry. More confidence is evidenced in the fields of propulsion and guidance.

Preparations for testing of the *SSBS* have already begun on the Saharian test-range at Colomb Béchar (Hammaguir) in the direction of Reggane.

Half-mobile shelters will be used in the calibration tests of the trajectories of the missile in the Sahara. These same shelters were used in the latest atomic test, instead of hard-built, more expensive structures.

Indications show that the second French atomic weapon is a much lighter instrument than the one first tested, since it was flown from France to Reggane entirely assembled. Neither is operational.

how soon will space travel take place? A. Dorodnytzin, member of the USSR Academy of Sciences, is certain that it is not far off. In fact, he said that "there is no doubt that within the life span of our generation man will set foot on the planets of our Solar system and, of course, first of all on the moon."

It is interesting to note that in May, 1959, N. P. Barabashov, a member of the Ukrainian Academy of Sciences and also director of the Kharkov State University Observatory, stated that, "one of the first problems in the development of astronautics is the launching of an interplanetary ship to orbit the moon at very close range to give us detailed information about the moon's surface and the physical conditions on it. This ship will have TV cameras and other complicated equipment . . ."

Dr. Barabashov probably knew what he was talking about, as soon afterwards *Lunik III* did exactly what he predicted. Prof. Barabashov, by the way, is in charge of the Soviet investigation of the physical structure of the moon. The next step will be to land a rocket on the moon to measure temperatures and analyse soil properties at various depths, said Dr. Barabashov. All this will be an important step toward man's eventual ascent into space.

• **Detailed timetable**—Soviet Academician L. I. Sedov, who recently was elected President of the International Astronautical Federation, has presented quite a detailed statement relating to a timetable of further explorations of the Universe.

Sedov stated that, from all indications, the work in the field of astronautics will follow the following three paths: first, experiments will be continued with launching the earth's satellites to solve many of the yet unsolved problems, particularly the practical application of acquired knowledge.

The second step will be flights to the moon. Successful launching of the Soviet rocket to the moon on Sept. 12, 1959, blazed the way, he said, for further work in this field. It certainly leads the way for manned rockets to fly to the moon and land there. This stage of space exploration, definitely not in the field of scientific fantasy, still presents enormous difficulties, especially a return of the rocket to earth. Still more difficult will be the creation of special scientific stations on the moon. However, he said, "many things that seem to be Utopian at present will become a reality in the near future."

Finally, according to Sedov, flights within our Solar system, namely to Mars and Venus will be undertaken. "Interplanetary flights are becoming a reality in our era," he added.

• **Food for flight**—A problem of food supply for future astronauts was discussed by G. A. Arutyunov in the January issue of the USSR Illustrated magazine. He said that "scientists of other countries are inclined toward synthetic mixtures of amino acids and carbohydrates . . . Soviet scientists prefer natural products enriched with amino acids." The main problem will be in flights of several months' duration.

According to Arutyunov, two solutions are suggested. "The first is to create new foods by chemical means—proteins, fats, carbohydrates and vitamins can be obtained from the products of nitrous metabolism. The second is the use of microorganisms and water plants. Scientists have already found about 15 varieties of water plants that can serve as adequate human foods. A plant called chlorella has particular merit since it also converts carbon dioxide into oxygen . . . Another problem is the water supply. On a long flight it can be obtained either from the air in the cabin which settles in drops on the cooled surfaces or by chemical means."

Future flights into Cosmos will solve any questions of the existence of life similar to that of Earth. Soviet academicians Oparin and Fesenkov estimate that life similar to ours is possible on only one in a million of the planets of our Galaxy. Even at this conservative estimate, it means that life is possible on at least 150 thousand planets!

Germans Build Rocket Test Site at WWII Installation

BERLIN—A testing site for rockets and ramjet propulsion units is under construction by the German Research Establishment for Aviation at the site where much of Germany's early rocket work was done.

The installation is located at Trauen, near Soltau, the same place Dr. Eugen Saenger conducted his rocket research and development during World War II, and where the studies on the "Long Range Rocket Bomber" were conducted. This was the famous "skip" re-entry concept, forerunner of the US Air Force *Dyna-Soar*.

Scheduled for operation in the spring of 1960, the project includes a one-kilometer-long rail track for steel rocket sleds with Mach speeds. The operation is subsidized by the German Federal Ministry of Defense.

West German Scientists To Study Space Problems

BERLIN—West Germany has formed a group of top-level scientists representing several disciplines to research problems of space flight.

Created by the German Rocket Society, the group includes Prof. Ehmert, Max Planck Institute of Aeronomy; Prof. von Diringshofen, an expert in aviation medicine; Prof. Dr. Schuette, astronomer at University of Munich; and Dipl.-Ing. Staats, President of the German Rocket Society. The group will conduct its work in Hanover.

The German Rocket Society maintains development and production workshops in Bremen. Membership totals more than 400, representing 14 countries. Among honorary members in the U.S. are Profs. Dornberger, Oberth, Wernher von Braun, and Saenger.

Space Telescope Slated For Launch from Woomera

A space telescope—mounted in the nose cone of a *Skylark* rocket—will soon make its first flight at the Woomera range in Australia. The rocket will reach a height of 100 miles above the earth's surface before taking pictures.

The telescope will build up a television type picture of hitherto unknown aspects of the sky and, at the same time, measure the intensity of ultraviolet light beyond the earth's atmosphere. This picture will be transmitted to earth via a radio-telemeter. Scanning will be accomplished by the yawing motion of the vehicle.

Six photo-amplifiers in the telescope—each fitted with a pure quartz window and transparent gold cathode—are set at various angles to the vertical so as to look at different areas of the sky.

Combined readings will build up a composite picture of space and will distinguish between point sources of ultraviolet light from stars and other sources of light such as gaseous nebulae.

A moon-detector in the unit is used to accurately establish the direction in which each photo-amplifier is looking at any instant.

The bearing of the earth's magnetic field is also taken by a magnetometer, and bearings on the earth's horizon are obtained from the photo-amplifiers themselves.

The telescope is expected to be in use only five minutes—but it is hoped that during that time results will give positioning precise to one degree.

Tiny 'Dice-Sized' Module Produced

Development of a tiny, dice-sized sub-module said to be the most compact circuit unit ever designed for off-the-shelf electronics components has been announced jointly by the United States Army Signal Corps and Republic Aviation Corp. The half-inch cube modules, each holding anywhere from 12 to 18 components and weighing only two grams, will be used in the guidance system of the AN/USD-4 *"Swallow"* reconnaissance drone the company is building for the U.S. Army's Signal Corps.

Engineers of Republic's Missile Systems Division, Mineola, N.Y., say the module is suitable for use in any all-purpose digital computer whether for military or commercial use. It has a packing density of a quarter of a million parts per cubic foot, or five times the density attainable through standard circuit techniques.

In other words, the large printed circuit boards required to mount several hundred resistors, diodes, transistors, capacitors and other components take up five times the space needed by the same components in this modular form. This miniaturization of "packaging," say the engineers, allows the building up of an extensive logic capability for a computer without materially adding to its overall size—or, conversely, to provide for normal logic capability at considerably reduced size.

Discussing use of the modules in the navigational computer which is the "heart" of the *Swallow's* central "nervous system," Republic's missile engineers say the units are arranged on modular "cards" at a rate of 44-50 per card. Use of the module technique in computers is not new, say the engineers, but the smallest general purpose computer on the commercial market today holds the equivalent of only 8-10 modules per card. Furthermore, say the engineers, the new units are uniform in size, which means the cards can be stacked on top of one another with no wasted space.

One of the main design features of the new module is its encapsulation. Electronic components when densely packed often cause one another to heat up to an excessive degree. The encapsulating material used here eliminates so-called "hot spots" by evenly distributing the heat. It also seals the circuit against moisture.

Another feature stressed by the designers is the use of standard components. Because of the high stress requirements of an airborne computer it is necessary to use elements of proven reliability, rather than newly developed units that might not hold up under environmental pressures, they point out. Furthermore, since silicon semiconductor components are used in Republic's new module circuits, the components are expected to perform with complete reliability in a temperature range of from –70 to +240°F. They can withstand a thermal "shock" of 100 degrees per minute.

Circle No. 225 on Subscriber Service Card.

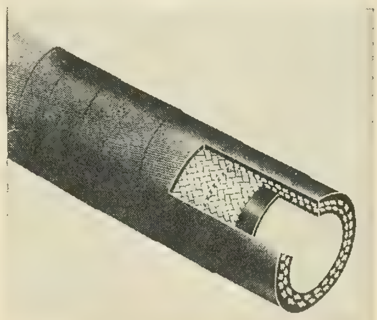
Teflon-Lined Hose

A special R/M hose, Flexlon, withstands all known chemicals except fluorine gas, chlorine trifluoride, and molten alkali metals.

This hose, manufactured by the Manhattan Rubber Division, Raybestos-Manhattan, Inc., has very low permeability, and zero water absorption. Since nothing will stick to the waxy Dupont Teflon tube, cleaning and sterilization are easily accomplished. Another advantage claimed for Flexlon is its flexibility and easy handling.

Flexlon Hose construction features a unique bonding of the glossy Teflon tube to the hose body, which is said to eliminate separation, cracking or splitting—even with small bending radii. Plies of high tensile cotton cords or special braided steel wire, (depending on pressure or temperature) form the strength members, securely bonded to the tube and heavy-duty cover.

Flexlon hose is especially suited for hot paint and lacquer spraying processes, for flexible connections in process equipment handling corrosives, caking slurries or solvents, and for conveying pharmaceuticals, milk, foodstuffs, and other fluids requiring sterilization and easy cleaning. Temperatures to 325°



F and working pressures to 1500 psi are acceptable, depending on size and type of hose.

Flexlon Hose is available regularly in diameters to 1¼ in. in 15 to 50 ft. lengths, (depending on size) with brass or stainless steel fittings. Larger sizes can be supplied on special order.

Circle No. 226 on Subscriber Service Card.

Severe Temperature Gloves

A new glove which industry, science and the armed forces will find useful wherever extremes of temperature are encountered during the Space Age is now being manufactured and marketed by J. M. Rubin & Sons.

Severe laboratory tests of the new glove, known as Fotiaire, have provided complete protection to the wearer at temperatures of absolute zero (460° below) and at 1200° above.

Fotiaire is manufactured in three

parts. The basic glove (left in photo) uses a combination of air and quality rubber to provide outstanding protection for the hand. A specially tanned leather glove is worn over the basic glove for protection from cold and a covering aluminized asbestos glove replaces the leather shell for protection from heat.

Contrary to appearances, the glove is not bulky. The forefinger construction enables wearer to manipulate instruments and dials with ease.

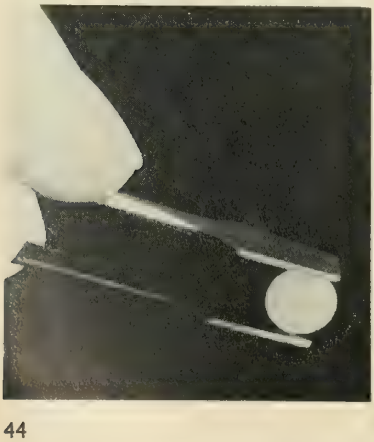
Tests made on the glove include the holding of liquid nitrogen in the cupped palm of the glove while being worn. The hand remained completely warm while the liquid nitrogen evaporated and there was no ill effect whatever on the leather. Metal parts overheated to 1200° have been held in hands protected by Fotiaire with no discomfort. Also, Fotiaire-protected hands have been immersed in boiling water with no ill effects to the wearer or to the gloves.

Circle No. 227 on Subscriber Service Card.

Moisture Getters

Development of tiny moisture getters for semiconductors has been announced by Corning Glass Works.

The company said the getters comprise the initial volume application of its porous, or "thirsty" glass. Production of the getters in the millions already has begun in several configurations.



The material of which the getters are made is Corning's 7930 glass—the porous form of its 96% silica glasses that go into Vycor brand products. An advantage of the material, besides its ability to absorb moisture, is its mechanical strength. This allows easy handling and mounting of the getters in transistor and diode enclosures.

Corning said getters are available immediately in the form of discs, with or without holes, in thicknesses of .030-inch or more. Large quantities can be produced in three weeks to meet requirements of other designs, the company said.

Prices are dependent on the design and the quantity ordered.

Circle No. 228 on Subscriber Service Card.

5 Watt Power Supply

Magnetic Research Corp. announces a series of new airborne instrumentation power supplies capable of supplying a stable source of DC power for instrumentation, telemetering and recording systems. Three models are available, offering a nominal output of either 5 volts, 10 volts, or 15 volts DC. All models operate from standard airborne 115 volts 400 cycle power and afford excellent regulation and ripple characteristics.

The design of these power supplies features dual magnetic power regulation consisting of a flux oscillator and a magnetic amplifier regulator. These circuits suppress line voltage transients and are essentially unaffected by changes in load or by line frequency variations. Construction features high-temperature magnetic and solid-state components, which enables these units to successfully withstand applicable portions of MIL-E-5272A.

Small quantities of all units are available from stock. Prices are available on quotation.

Circle No. 229 on Subscriber Service Card.

new literature

FLAME SPRAY PROCESSES—An engineering data bulletin on basic flame spray processes has just been published by Metallizing Engineering Company, Inc. The 16-page bulletin covers the metallizing process which sprays powdered metals, including tungsten carbide and self-fluxing alloys of the boron-silicone, nickel, chromium type and refractory ceramics, such as aluminum and zirconia; and the new METCO Plasma Flame Spray process which develops temperatures up to 30,000°F. and can spray any material that can be melted without decomposition. In addition to covering the basic engineering considerations for each process, the bulletin includes tables and charts on specific characteristics of these coatings, such as hardness, tensile strength, bond strength, etc. Illustrated and described and typical applications of these coatings in the production of original equipment. One section of the bulletin illustrates a typical automatic production set-up as well as the requirements for a typical research department installation.

Circle No. 200 on Subscriber Service Card.

MISSILE LAUNCHER FLUID—Data on Ucon Hydraulic Fluid M-1, specifically developed for the *Titan* missile's hard-site installations, has just been published by Union Carbide Chemicals Co. American Machine and Foundry Company, contractor for a series of *Titan* hard-sites, was faced with finding a hydraulic fluid able to meet severe operating conditions safely. Ucon Hydraulic Fluid M-1, developed specifically for the *Titan* by Carbide, was the only such fluid with operational capability from minus 35 to plus 160°F; satisfactory liquid and vapor-phase corrosion inhibition over this range; resistance to spray flammability in 100% oxygen atmosphere with an electric arc ignition source; resistance to detonation under 320 foot-pound per square inch impact force in the presence of liquid oxygen; and adequate lubricity for rotary gear, vane, and axial piston pumps. The new 8-page data booklet describes the properties and handling of Ucon Hydraulic Fluid M-1, with information on viscosity-temperature relationships, effect on rubber and metals, results of pump tests, and other data.

Circle No. 201 on Subscriber Service Card.

VACUUM LABORATORY—An illustrated technical data sheet has been issued describing research facilities available in the new Space Vacuum Laboratory of National Research Corporation.

Circle No. 202 on Subscriber Service Card.

DOD Tries To 'Disown' Gale Letter

Just as quickly as it leaked out the Defense Department last week tried to disown a letter purporting to detail the "combined thinking" of Defense Secretary Gates and his top military advisors on the "missile gap."

The letter—which states flatly that "reliance on manned bombers at the present time makes a good deal more sense for the U.S. than does reliance on the ICBM"—was written by one-time advertising man Oliver M. Gale, now a special assistant to Gates.

Flustered DOD spokesman hastily assured newsmen that Gale's 4000-word rendition of the nation's military posture was "unofficial," something "he did all by himself without showing the Secretary." However, in the letter to American Machine & Foundry President Carter L. Burgess, a former assistant secretary of defense, Gale said the paper had been "cleared by Security Review."

It also was revealed that more than 600 copies of the letter had been distributed by Gale to "opinion leaders" in business and government, as one observer put it, apparently because "he was so proud of it."

In essence, the Gale statement hews to the long-established Eisenhower Administration concept that bombers are more reliable and accurate than ICBM's and are therefore the "most efficient" defense; and that in overall military strength the U.S. is considerably ahead of Russia and will remain so.

Obviously intended to offset Democratic criticism of Eisenhower Administration defense policies, the letter was said to be inspired by Vice President Nixon and other leading Republicans.

• **Amateurish and political**—Military men who looked at the letter passed it off as "amateurish," containing "superficial reasoning," and "obviously politically motivated." They said Gale had disregarded a wealth of military advice he could have obtained right in his own building—the Pentagon.

Some items from the letter:

• "If our security demanded it, we would of course have produced the *Atlas* in greater numbers. This country could have turned out almost any number it wished."

• "Because of the promise of second generation ICBM's and the diversity of offensive weapons, both air and seaborne, the U.S. has settled on a minimum number of first generation ICBMs. We already have the deterrent potential that permits us to hold back and wait for superior weapons."

• The B-70 was cut back because it "could not be operational before 1965 at the earliest and probably not until 1967 or 1968. By 1965 four systems of ICBMs will be operational—*Atlas, Titan, Minuteman and Polaris* . . ."

In answer to whether 300 Soviet missiles could wipe out U.S. retaliatory capability, as claimed by SAC Commander Thomas Power, Gale said:

If the Soviets had launchers for a stock of 300 missiles, if countdowns for all of them were perfect, if our intelligence did not detect such a massive effort in advance, if all our strategic bombers and carriers were located or if the bombers were all on the ground—in short, if the Soviets are willing to gamble on every detail working perfectly—such a sneak attack might be effective. "Obviously the chance that all these conditions would occur simultaneously are remote."

Range Responsibility Now York's

Responsibility for central control of all U.S. test ranges, tracking stations and other support facilities has been given to the Director of Defense Research and Engineering (DDR&E), Dr. Herbert F. York.

The decision to provide a single office for range coordination and supervision was made by Defense Secretary Thomas Gates after a six-month management study of all the missile/space test ranges.

The action is based on the recommendations presented by Walker Cisler, consultant to the Secretary. No formal report was prepared, according to Dr. York, but Cisler's oral and written recommendations have been presented to Gates over the past few months.

The new centralization, said York, has two objectives: single effective control for more efficient ground environment coordination and better liaison between the Department of Defense and the National Aeronautics and Space Administration.

To carry out this control, Air Force Major General Donald N. Yates will be reassigned as deputy director of DDR&E. Yates will be relieved shortly as Commander of the Atlantic Missile Range.

Also Alvin G. Waggoner, who assisted Cisler in the range study, will be named assistant director under York. Waggoner will establish the necessary staff and facility to carry out the new control program.

In the past, effective control and supervision of the ranges had not been formalized because all the problems were not fully understood, said York.

York's office now will set up and maintain an information center including an inventory of all test plans requiring range and ground equipment use. Long-range schedules will be maintained.

All future proposals for range use and for development, procurement, installation and operation of ground environment equipment (items not considered an integral part of a weapon system) to be used in the R&D, test, and evaluation of missiles and space programs must now be approved by DDR&E.

• **Responsibilities**—Under the new authority, Yates will act for DDR&E in all matters which involve missile and test ranges and all other associated ground stations. Because of his long background in command of missile facilities and launchings (six years at Cape Canaveral), it is expected that the General will be a strong force in guiding future range programs.

After organizing his staff, Waggoner will

• Establish and maintain inventory records of all ground environment support of all space programs and at all missile ranges, training and test facilities.

• Establish and maintain an inventory of plans for the development, procurement and installation of new equipment for the facilities above.

• Establish and maintain an inventory of test plans requiring the use of existing or projected ground environment support equipment or facilities. This will involve the continuous maintenance of a complete schedule of all future launch dates—(thus, this will be the first central information pool for such data).

Waggoner's group also will recommend to DDR&E range assignments for future missile and space programs. It will approve, modify or turn down all DOD proposals for new or additional facilities and proposals for installing NASA equipment or military sites.

Finally, the group will monitor all proposals to avoid unnecessary duplication between DOD and NASA and arbitrate when conflicts arise on use of ranges and launch facilities.

AIR FORCE

$33,058,690—**Western Electric Co., Inc.**, New York City, for tracking system for Project *Mercury*.

$900,000—**General Electric's Light Military Electronics Department** for study and development contract which encompasses Electrostatic Latent Image Photography.

$639,500—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for development and test of rocket motor applicable to the *MB-1* air-to-air rocket.

$350,000—**CompuDyne Corp.**, Hatboro, Pa., for instrumentation and control components for propellant-loading systems at six *Atlas* ICBM operational bases.

$250,000—**Martin**, Denver, for venting connectors on the *Titan* launching complexes.

$224,343—**Aerojet-General Corp.**, Azusa, Calif., for solid propellant combustion research.

$199,284—**Olin Mathieson Chemical Corp.**, Baltimore, for propellant.

$187,890—**Washington University**, St. Louis, for "investigations of strong (cyclotron induced) interactions and of the weak interactions of beta decay."

$139,184—**University of Pittsburgh**, for continuation of research on "magnetic and structure properties of solids and solutions.

$78,000—**General Electric Co.**, Schenectady, N.Y., for research on interactions of gases with nonmetallic surfaces.

$72,020—**Vitro Laboratories**, West Orange, N.J., for research on physical properties of high-intensity arc.

$65,904—**Polytechnic Institute of Brooklyn**, for research on investigation of the effects of phase, transformations of the properties of solids.

$65,000—**University of Colorado**, for research directed toward development of miniature radiometers for high-altitude vehicles and a program for the reduction of data obtained with these radiometers.

$64,494—**General Electric Co.**, Cincinnati, for continuation of research on high temperature heat transfer.

$60,064—**Universal Match Corp.**, St. Louis, for servometer.

$57,906—**Vitro Laboratories**, West Orange, for design and development of laboratory device for simulating solar energy and spectral distribution of solar radiation.

$57,105—**Lockheed Aircraft Corp.**, Sunnyvale, Calif., for research on theory of composite propellant burning.

$55,132—**Atlantic Research Corp.**, Alexandria, Va., for research on solid propellant combustion.

$49,729—**University of California**, Berkeley, for research on tolerance and adaptability of the brain to environment imposed by space flight.

$48,756—**Stanford Research Institute**, Menlo Park, Calif., for investigation of solid-state electrolyte behavior in semiconductors.

$40,360—**Washington University**, St. Louis, for research on primary cosmic ray composition and ray variations.

$37,812—**Kaiser Fleetwings, Inc.**, Bristol, Pa., for services and materials 6-100 foot inflatable satellite container assemblies.

$37,737—**Washington University**, St. Louis, for continuation of research on problems in mathematical analysis.

$33,332—**Stanford Research Institute**, Menlo Park, for the study of the origin and propagation of disturbances in the burning of solid propellants.

$29,490—**University of California**, Berkeley, for studies of complete biological systems for manned space vehicle, space station or extraterrestrial base.

$27,073—**Pennsylvania State University**, University Park, gasdynamics of plasmas.

$25,570—**Allied Research Associates, Inc.**, Boston, for research in analysis of heat conduction and convection in aerostructures.

$21,820—**University of California**, Berkeley, high-precision geocentric orbits.

ARMY

$2,184,000—**Temco Aircraft Corp.**, for manufacture of components of the *Hawk* air-defense missile.

$1,687,000—**The Martin Co.**, Orlando, for engineering services for *Lacrosse* weapon system—supplement.

$1,331,725—**Douglas Aircraft Co.**, Santa Monica, for repair parts for the *Nike* system (three contracts).

$1,011,414—**Raytheon Co.**, Waltham, for concurrent repair parts, *Hawk* missile system (two contracts).

$369,624—**Western Electric Co.**, New York City, for *Nike* spare parts and components (four contracts).

$154,900—**Domestic Film Prod. Corp.**, Millersburg, Ohio, for tent, *Nike-Hercules*, air-supported, complete, without fan.

$95,000—**General Electric Co.**, Pittsfield, for development of cryogenic gyro.

$86,781—**Biltmore Construction Co.**, Clearwater, Fla., for NASA Minitrack facility.

$86,573—**Barnes Engineering Co.**, Stamford, Conn., for design, development and fabrication of prototype horizon sensor system.

$48,490—**Western Electric Co.**, New York City, for *Nike* spare parts and compounds.

$29,447—**CBS Laboratories, Div. of CBS, Inc.**, Stamford, for study of development in ball bearings for space application.

$28,008—**Douglas Aircraft Co.**, Santa Monica, for *Nike* replenishment spare parts.

NAVY

$38,500,000—**Westinghouse Electric Corp.**, for developing and producing a prototype model of the long-range radar for a new ship-based antiaircraft and missile weapons system.

$10,868,269—**Sperry Gyroscope Co.**, Syosset, L.I., N.Y., for field service and liaison engineering on Type II periscope drive system.

$8,817,022—**Sperry Gyroscope Co.**, Syosset, for design of navigation subsystem.

$4,895,000—**General Electric's Light Military Electronics Department**, for continued production of the *Sidewinder* air-to-air guided missile.

$2,561,000—**The Martin Co.**, Orlando, for development of a modified version of the *Bullpup*.

$700,000—**Hermes Electronics Co.**, for design and manufacture of space guardians, for use in the Navy's artificial Earth Satellite Observation Program (AESOP).

$325,000—**The Diehl Manufacturing Co.**, Finderne, N.J., for cover resolvers to be used chiefly as government-supplied equipment to prime and sub-contractors.

$200,000—**Radar Relay, Inc.**, Santa Monica, for readout and electronic control display units for *Polaris* missile checkout system to be installed aboard *Polaris*-firing submarines.

$174,563—**Industro Transistor Corp.**, L.I., N.Y., for germanium alloy junction transistors for the *Polaris* missile program.

$152,529—**Wallace & Tiernan, Inc.**, Belleville, for bathythermographs.

$58,268—**Battelle Memorial Institute**, Columbus, Ohio, for studies and investigation of the mechanism of cracking of weldments of submarine hull structures made from HY-80 steel.

MISCELLANEOUS

$1 million+—**Lear, Inc.**, for manufacture of universal component test stands for ICBM rocket engine.

$100,000—**Lear, Inc.**, for production of test stand couplings for the Rocketdyne 150-million-h.p. engine.

—reviews—

CONTAMINATION CONTROL OF LIQUID PROPELLANT ROCKET ENGINES. Order from Aerospace Industries Assn., 610 Shoreham Bldg., Washington 5, D.C.

The handbook has been prepared by a team of specialists from government and industry and is being sponsored by the Guided Missile Council and Propulsion Technical Committee of the Aerospace Industries Assn. Copies are available to any organization concerned with design, development, manufacture, procurement, inspection, storage or handling of components or complete engine systems.

UPPER ATMOSPHERE RESEARCH REPORT NO. 35: GROUND STATIONS FOR NRL ROCKET STUDIES OF THE IONOSPHERE. J. E. Jackson and G. H. Spaid, NRL. Order PB 151763 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. $1.

The Navy's use of high altitude sounding rockets transmitting signals to Earth has made measurements of the ionosphere possible and exploded the theory of separation of its E, F_1 and F_2 layers.

The report explains techniques for operating narrow band receiving equipment on the ground. Innovations described include a new type crystal filter, an adaptation of the "magic T" at 7.75 megacycles and more stable rf sweep generators, used to calibrate ground station gear.

—when and where—

APRIL

International Symposium on Active Networks and Feedback Systems, sponsored by Polytechnic Institute of Brooklyn, Dept. of Defense Research Agencies, Institute of Radio Engineers, Engineering Societies Bldg., New York, April 19-21.

Society of Plastics Engineers, North Texas Section, Annual Regional Technical Conference, Hotel Texas, Fort Worth, April 20.

National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, co-sponsored by National Aeronautics and Space Administration, and The Rand Corp., Ambassador Hotel, Los Angeles, April 20-22.

Symposium on Electrical Conductivity in Organic Solids, Air Force Office of Scientific Research and Office of Naval Research, Duke University, Durham, N.C., April 20-22.

Royal Aeronautical Society, On Reducing Costs of Space Research, London, April 21.

Southwest Metals and Minerals Conference "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles, April 21-22.

Seventh Annual Heat Transfer Conference, "Survey of Radiation Phenomena and Heat Transfer Equipment for Space Flight Application," Oklahoma State University, Stillwater, April 21-22.

American Ceramic Society, 62nd Annual Meeting, Bellevue Stratford Hotel, Philadelphia, April 24-28.

The Combustion Institute, Western States Section, Spring Meeting, sponsored by Lockheed Aircraft Corp., Palo Alto, Calif., April 25-26.

ASME Maintenance and Plant Engineering Conference, Chase-Park Plaza Hotel, St. Louis, April 25-26.

American Welding Society, 41st Annual Meeting and Welding Exposition, Los Angeles, April 25-29.

2nd Southwestern Metal Exposition and Congress, State Fair Park, Automobile Bldg., Dallas, April 25-29.

National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton-Gibson Hotel, Cincinnati, April 27-28.

British Interplanetary Society, High Altitude Chambers and Pressure Suits, Church House, London, April 28.

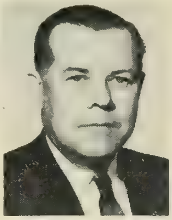
MAY

National Association of Relay Manufacturers, Eighth Annual Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, May 3-5.

Materials Handling Exhibition and Convention, Mechanical Handling, sponsored by Associated Iliffe Press, Dorset House, Stamford St., London, May 3-13.

Radiation Research Society, Annual Meeting, San Francisco, May 8-12.

Russell C. Galbraith: Named to the new post of vice president - administration at Lockheed Electronics Co., responsible for financial and legal matters, industrial relations, public relations and organizational planning. Was general manager of the Lockheed Electronics and Avionics Division before the consolidation of that division and the former Stavid Engineering, Inc. into Lockheed Electronics Co.



GALBRAITH

Darwin W. Mark: Formerly with Marquardt Aircraft's engineering department and vice president of Rowin Plastics, appointed technical director of Nash-Hammond, Inc.'s Fiberglas and Plastics Division.

Edward L. Maguire: Former assistant general manager of The Alloy Fabricating Div. of Standard Steel Corp., appointed manager of Cryogenics for Uni-Flex Manufacturing and Engineering, Inc.

John A. Farris: Named manager of engineering liaison by Aircraft Porous Media, Inc., a subsidiary of Pall Corp.

John B. Suomala: Formerly with the Instrumentation Laboratory at Massachusetts Institute of Technology, named vice president-engineering at Gabriel Electronics Division, The Gabriel Co. At M.I.T. he had staff and line responsibilities for inertial guidance systems of ICBM programs; automatic ground environmental systems and antenna systems including the Air Force early warning radar antennas systems.

SUOMALA

Thomas J. Lynch: Elected vice president of Vector Manufacturing Co., Inc., and **Charles Weidknech,** vice president and general manager of Vector Communications, Inc., a wholly owned subsidiary. Lynch was formerly with the test engineering and computer section of Philco Corp. and with Tele-Dynamics. Weidknech was previously associated with Tele-Dynamics and General Electric Co.'s Missile Division.

Aero-Flex Corp., appoints **George Lewis** as vice president-operations and **Phil Hobbes** as vice president-product engineering.

Edward C. Grimshaw: Named manager of United Aircraft Corp.'s Norden division's Data Systems department.

Robert E. Dryden: Elected vice president-engineering at Pearce-Simpson, Inc., heading the new Research and Development Division. Formerly directed the instrumentation division of Radiation, Inc.

John W. Ryberg: Formerly with Goodyear Tire and Rubber Co., appointed application engineer for the Aero Hydraulics Division of Vickers Inc.

Robert E. Steinman: Former product manager, Charles Bruning Co., Inc., elected vice president of Gaertner Scientific Corp.

Dr. Harald T. Friis: Retained as a consultant by Wheeler Laboratories, Inc., a subsidiary of Hazeltine Corp. Dr. Friis retired two years ago as director of Research in High Frequency and Electronics at Bell Telephone Laboratories, Inc. He served on the panel for basic research, Research and Development Board, and on the Air Force's Scientific Advisory Board. Has received various awards for his scientific contributions, including the Morris Liebmann Memorial Prize, Medal of Honor of the IRE and the Stuart Ballantine Medal.

FRIIS

William A. Linton, Jr.: Formerly president of LaRoe Instruments, Inc., joins the staff of Rixon Electronics, Inc., as staff engineer-physicist.

Donald L. Erickson: Former chief production engineer promoted to production manager at Brooks & Perkins, Inc. Previous posts: Tool designer and process engineer with Ford Motor Co., and production engineer with Goodyear Aircraft Co. and Bell Telephone Laboratories.

Herman O. Mueller: Appointed head of the newly-formed Special Products Development Dept. of The Liquidometer Corporation.

Marshall C. Harrington: Succeeds **John P. Craven** as Contract Research Administrator at the Navy's David Taylor Model Basin. Dr. Harrington was formerly head of the Fluid Dynamics Branch. Dr. Craven is now chief scientist, Special Projects Office, Dept. of the Navy.

Arthur C. Metzger: Former coordinator and manager of the test equipment program at Frankfort Arsenal, joins General Precision, Inc.'s Kearfott Division as senior project engineer in the firm's Provisioned Military Equipment Laboratory.

Dr. John T. Ludwig: Recently a senior research and development engineer with Minneapolis-Honeywell Regulator Co., appointed to Electronic Communications, Inc.'s Scientific Advisory Group as a principal engineering scientist. **Dr. Richard A. Ibison** also joins the firm as a Principal Engineering Scientist concerned with human factors engineering, maintainability and training.

R. A. Irwin: Appointed director of space activities, a new position at the Westinghouse Electric Corp.

Litton Industries Electron Tube Division promotes: **George S. Stuart** to production manager-Magetron Product Line; **John V. Lyddane,** production manager-Traveling Wave Devices Product Line; **Allen C. Ashley,** project engineer, Magnetron Product Line.

Cecil Young: Formerly with Peerless Electric, joins Hydro-Aire Co. as engineering manager of electro-mechanical equipment.

Charles M. Saffer, Jr.: Former technical coordinator of the AFN High Energy Fuels Program at American Potash & Chemical Corp. joins Thiokol Chemical Corp. as assistant director, Research Planning.

Bertram Magenheim: Former senior project engineer of the technical staff at R.C.A., joins Control Electronics Co., Inc., as Microwave Division head, responsible for overall design, development and manufacture of microwave components and instruments. Previous posts: Microwave signal generator group leader at Polarad Electronics Corp., microwave section head at FXR and electrical engineer at Raytheon Co.

MAGENHEIM

Gerald G. Loehr: Named manager-contracts and negotiation for Aerojet-General Corp., Washington office.

Solomon Charp: Manager of navigation and control electronic equipment for General Electric's Missile and Space Vehicle Dept., directing investigation of complete navigation and control electronic systems, design and development of control components and design of electronic circuitry.

Dean C. Reemsnyder and **George E. Shimp:** Promoted to project engineers in the engineering department of New Devices Laboratories, Thompson Ramo Wooldridge, Inc.

W. P. Horton: Formerly manager of Computer Control Co.'s Engineering Dept., Eastern Division, appointed vice president.

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BMEWS Signal Opens New RCA West Coast Facility

VAN NUYS, CALIF.—Telephone and tropospheric scatter communications brought a signal from a Ballistic Missile Early Warning System site near Thule AFB, Greenland, to Van Nuys last week. Occasion was the official dedication of Radio Corp. of America's new multimillion-dollar, 240,000-sq.-ft. electronics facility for the company's West Coast Missile and Surface Radar Div. (M/R, April 11, p. 18).

RCA's latest plant, described as one of the nation's most advanced facilities for engineering and production of ballistic missile checkout, guidance and control systems, is already in production of automatic checkout and launch control systems (APCHE) for the *Atlas* and autopilots for the *Thor*. New site is also producing Loran navigation equipment, weather radar for the USAF and Navy, countermeasures and BMEWS system elements.

Human Factors Research Begun by ACF, Catholic U.

A cooperative program in human factors research applied to space age electronics has just been announced by the Electronics Division of ACF Industries and Catholic University. Called a "model agreement," the program is believed to be the first between industry and an educational institution in the human factors field.

Under the agreement, the University will supply personnel and facilities of its experimental and physiological psychology laboratories. ACF Electronics will contribute engineering and production support as well as the services of its human factors department. In addition, the University's Department of Psychology and Psychiatry will be able to train students in the research program.

ACF Electronics has been active in human factors and human engineering in the design of aircraft simulation and other training devices since 1949. Dr. John Townsend, Professor of Psychology at CU has been retained as a consultant to ACF for the past three years.

The first broad research project under the agreement will be basic work on the dynamics of decision-making. According to the participants, study of human decision-making processes will contribute significantly to the understanding of man-machine relationships in the design of future defense and space systems.

Under today's concepts, many contemplated space systems must contain a man since his observation and decision-making capabilities cannot be duplicated by computers. Dr. Townsend contends that the most critical problem lies in teaching man to make better decisions. The human factors project is therefore aimed at finding ways to equip man to assimilate large quantities of data and arrive at the most intelligent decision based on the data.

First findings of the program are scheduled to be published next fall.

The Things We Stand For

The magazine MISSILES & ROCKETS was born in October, 1956, conceived and dedicated to serving the missile and space market.

This was one full year before the Russian *Sputnik* awakened the world to the electric possibilities of space exploration. It was before the International Geophysical Year. In October, 1956, neither *Thor* nor *Jupiter* nor *Atlas* had been fired from a launching pad. The *Titan* was still in the fabrication stage. The government was officially laughing at the idea of exploring the moon, front or backside.

MISSILES & ROCKETS was the first publication in the missile and space field. Since then a dozen or a score have rushed to emulate and follow. It is sincere flattery.

Ours is an exciting field, a changing, pulsating field where yesterday's wondrous discoveries are today's commonplaces; a field of new and strange materials, products and techniques—a field which questions basic scientific theories.

We at MISSILES & ROCKETS have changed some since 1956. We changed from a monthly to a weekly because news of the market demanded it. We have broadened our outlook as the missile/space horizon broadened. We are constantly changing the emphasis of our coverage as the market changes with new discoveries and new achievements. From our changes and our growth have come the beliefs and ideals for which the magazine stands. Simply stated, they are:

• That for the foreseeable future the missile is the preponderant weapon in military deterrence or offense and the United States must maintain a superiority in this field, whether these missiles be land, sea or air-based.

• That we must lead in the exploration of space, not only as a matter of pride and prestige but also because any nation or group of nations which can deny the use of space to others will find a way to utilize that advantage to control the world and perhaps the cosmos. Such control might be with weapons, commerce or technology—even some technology as yet undreamed of.

• That the government and industry must cooperate to achieve this superiority and leadership and that only through cooperation and mutual assistance will they be achieved.

• That this country's strength lies in its free enterprise system and that inherently our greatest achievements will always come from research, design, development and production by private industry rather than from use of the government arsenal system.

• That space is a place and not a project. NASA has a mission there for scientific exploration. The military—any or all of the Services—have a right and duty there to prevent illegal dominance by any other power. Other government agencies will utilize space in performance of their missions. Private industry will be there.

• That both government and industry must encourage advancements in science, recognizing that industry's strength rests on its technology. That both must support a strong program for increased scientific education.

We believe that both government and industry have great responsibilities in this new missile/space field.

For government:

• To never forget that private industry is the basic strength of the country.

• To maintain a productive and economically healthy defense industry.

• To assume greater costs in both basic and applied research.

• To make administrative adjustments which will permit recognition of the necessity of the negotiated contract, protection of industry's proprietary and patent rights, and a redefinition of rules covering the renegotiation of defense contracts.

For industry:

• To realize that the nation's requirements supercede the financial welfare of any single company.

• To realize that the costs of modern air, missile and space systems are so great that not all promising projects can be exploited.

• To rigidly apply realism and common sense to industrial proposals. Don't gain a sale and lose the country.

• To engineer realistically for function and reliability.

• To price realistically: don't gold-plate the product.

• To accept, together with the scientific community, the responsibility to maintain and increase our scientific and industrial leadership; to fight against stifling over-controls and even ineptness in government administration.

Clarke Newlon

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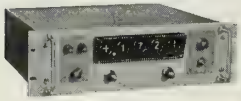

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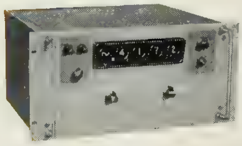

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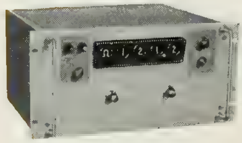

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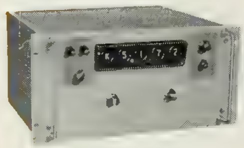

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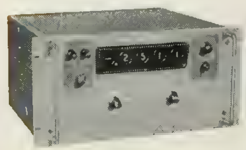

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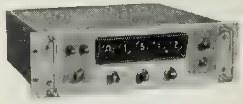

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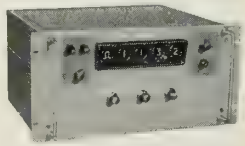

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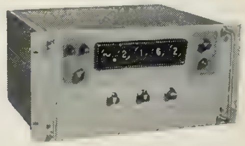

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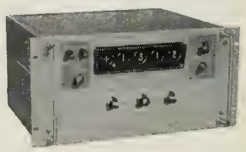

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Circle No. 12 on Subscriber Service Card.

April 25, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

Astronaut Fights to Leave *Mercury* Capsule

AN AMERICAN AVIATION PUBLICATION

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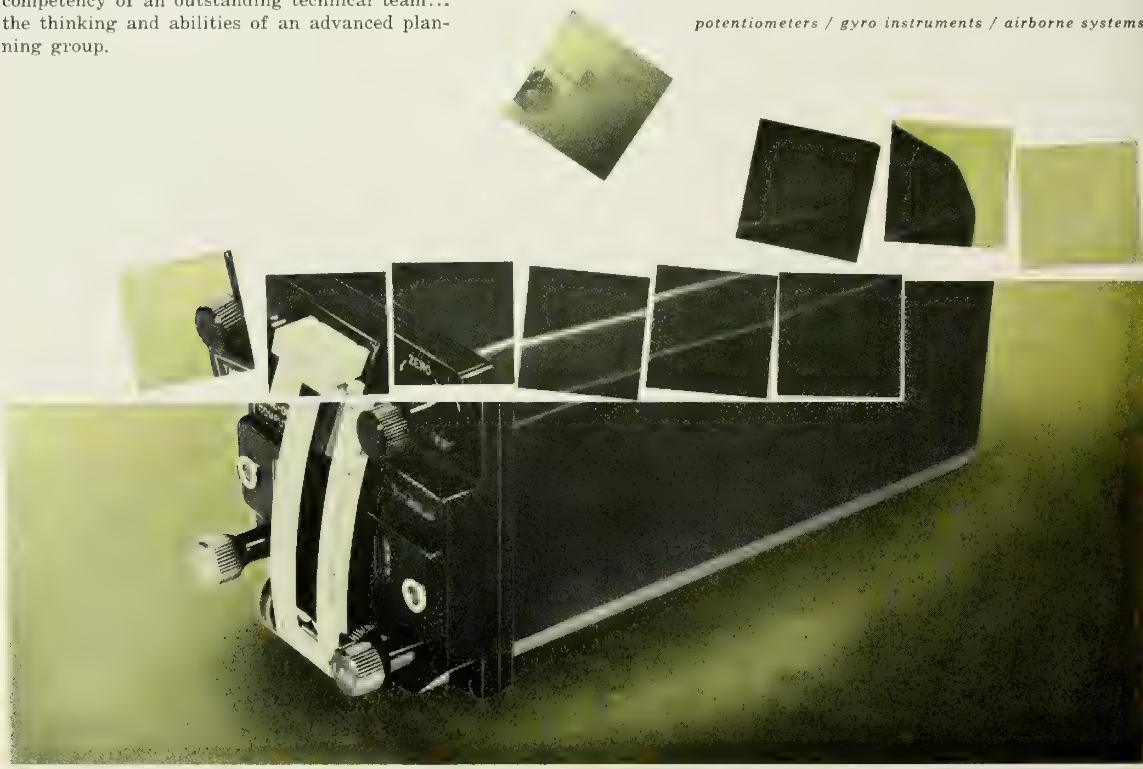

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W. M. Willis, Chief Engineer of Marman Division, displays some of the many couplings and joints developed by Marman engineers.

MARMAN

Leads in Joint and Coupling Engineering

Pictured at the left are a few of the many V-Band Couplings and Joints designed and produced by Marman for every aircraft and missile application. Marman V-Band Couplings are ideal for connecting all sizes of tubing, piping and ducting used in fluid transfer and structural applications. The lightweight Marman J13 V-Band Joint provides efficient sealing for pneumatic and hot air or gas lines. The J11 V-Band Joint may be used for fluid systems. Marman high-performance CONOSEAL Joints provide a leakproof seal where zero leakage is required over a wide temperature range.

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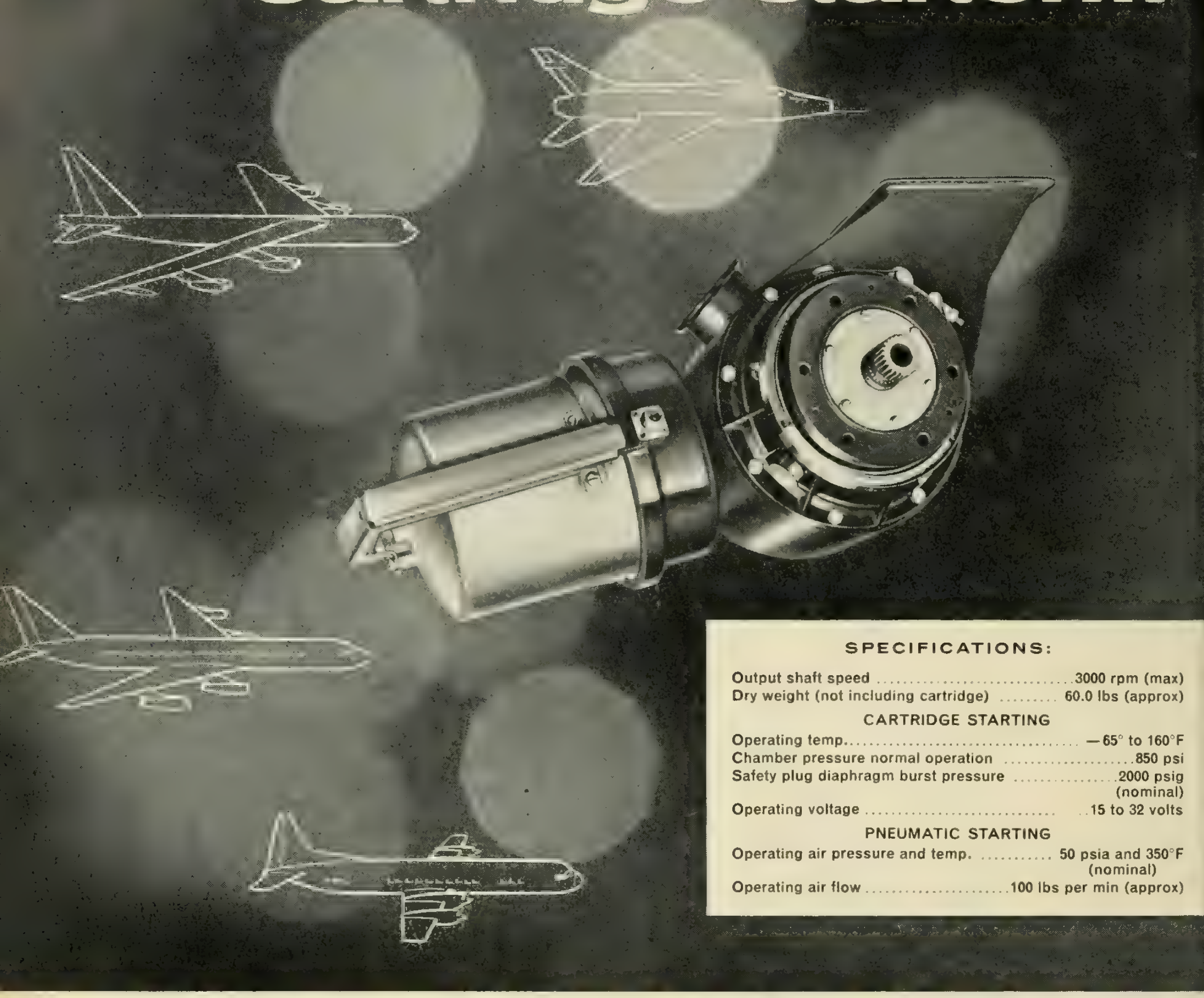

SPECIFICATIONS:

Output shaft speed	3000 rpm (max)
Dry weight (not including cartridge)	60.0 lbs (approx)
CARTRIDGE STARTING	
Operating temp.	—65° to 160°F
Chamber pressure normal operation	850 psi
Safety plug diaphragm burst pressure	2000 psig (nominal)
Operating voltage	15 to 32 volts
PNEUMATIC STARTING	
Operating air pressure and temp.	50 psia and 350°F (nominal)
Operating air flow	100 lbs per min (approx)

AIRESEARCH'S CARTRIDGE/PNEUMATIC STARTER *has completed more than 20,000 successful cartridge starts for the F-100, F-105 and Hound Dog missile applications.*

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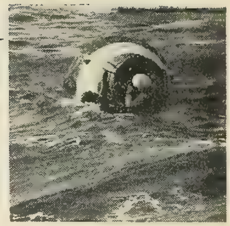
THE MISSILE/SPACE WEEKLY
missiles and rockets

April 25, 1960 Volume 6 No. 17



THE COVER

Project Mercury *astronaut struggles to leave his capsule during training off Pensacola. All seven astronauts have found maneuver very tough. See pictures, p. 20.*

APRIL 25 HEADLINES

ADVANCED MATERIALS

PROPULSION ENGINEERING

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30,700 copies this issue

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An American Aviation Publication

Circle No. 5 on Subscriber Service Card.

Cover Pros and Cons

To the Editor:

Congratulations on your new cover! The new format, added to your already thorough coverage of the missile/space industry, makes MISSILES AND ROCKETS even more inviting to read. Our best wishes for your continued success.

Ralph W. Sheehy
Specialist—Product Information
Defense Electronics Division
General Electric Co.
Utica, N.Y.

To the Editor:

We hope the M/R signature remains at the top of the cover. As you mentioned, its former location was hidden by the magazine rack and other means of display. We finally attached a card at the top for identification.

MISSILES AND ROCKETS seems to be a favorite with our Design and Engineering Departments and we look forward to each new issue.

So . . . we hope it stays with its new cover format.

Marjorie S. Sellstrom
Librarian
Missile Systems Division
Raytheon Company
Bristol, Tenn.

To the Editor:

With due respect to the artist involved and your expense, the new cover for M/R is just *too* ordinary for a magazine of this type. Your original cover was much more in keeping with its contents. More specifically, *keep* the signature on the lower portion of the page.

The inside changes are noticeably good, especially the idea to edit subject matter into departments.

As the mother of two small children, I find that M/R affords an excellent opportunity for me to keep abreast of the rapidly changing Space Age and thereby, intelligently discuss it with my husband and others.

Living this close to the Cape, and having a husband with Martin-Orlando, I crave all of the knowledge I can readily absorb . . .

Sorry I didn't go for the cover! Keep up to your standards.

(Mrs.) Grace H. Barnhart
Orlando, Fla.

ASW Section Greeted

To the Editor:

Your new ASW department makes a very significant contribution in assisting our planning of ASW activities. This is certainly a worthwhile addition to your already informative magazine.

William S. Wheeler
Vice President & General Manager
Military Electronics Division
Motorola Inc.
Scottsdale, Ariz.

anphier Progress Report

) the Editor:

Just saw a copy of your April 4 issue, which you gave my Press Club effort ch handsome coverage. For which, thank ou very much.

Thanks also for the thorough and ılid account you did in your magazine ı my appearance before the Space and :ience Committee. As a result of reportıg such as yours, I am having the satisıction, at last, of finding my point of ew clearly recorded for the consideraon of the sort of readers I appreciate aving an understanding of it.

I also note, from the public print ıese days, that the Administration is at :ast and at last beginning to shift its osition to some degree toward a more ppropriate direction—if not in an approriate order of magnitude.

Thomas G. Lanphier, Jr.
San Diego

leaction's Affiliation

o the Editor:

In an article on the *X-15* in a recent ssue of M/R, the writer credited developnent of the engine to "Reaction Motors nc." As you know, Reaction Motors has een a Division of Thiokol Chemical Cororation for about two years.

Because Reaction Motors was so long he only name identified with the engine's levelopment, we understand how easily a vriter can forget to identify the new ffiliation.

On the other hand, the Corporation xpects us to continually remind publicaions that the name Reaction Motors hould be used only when identified as a Division of Thiokol Chemical Corporation. If the full credit is not possible, then the name "Thiokol Chemical Corporation" or "(RMD) Thiokol Chemical Corporation" is sufficient.

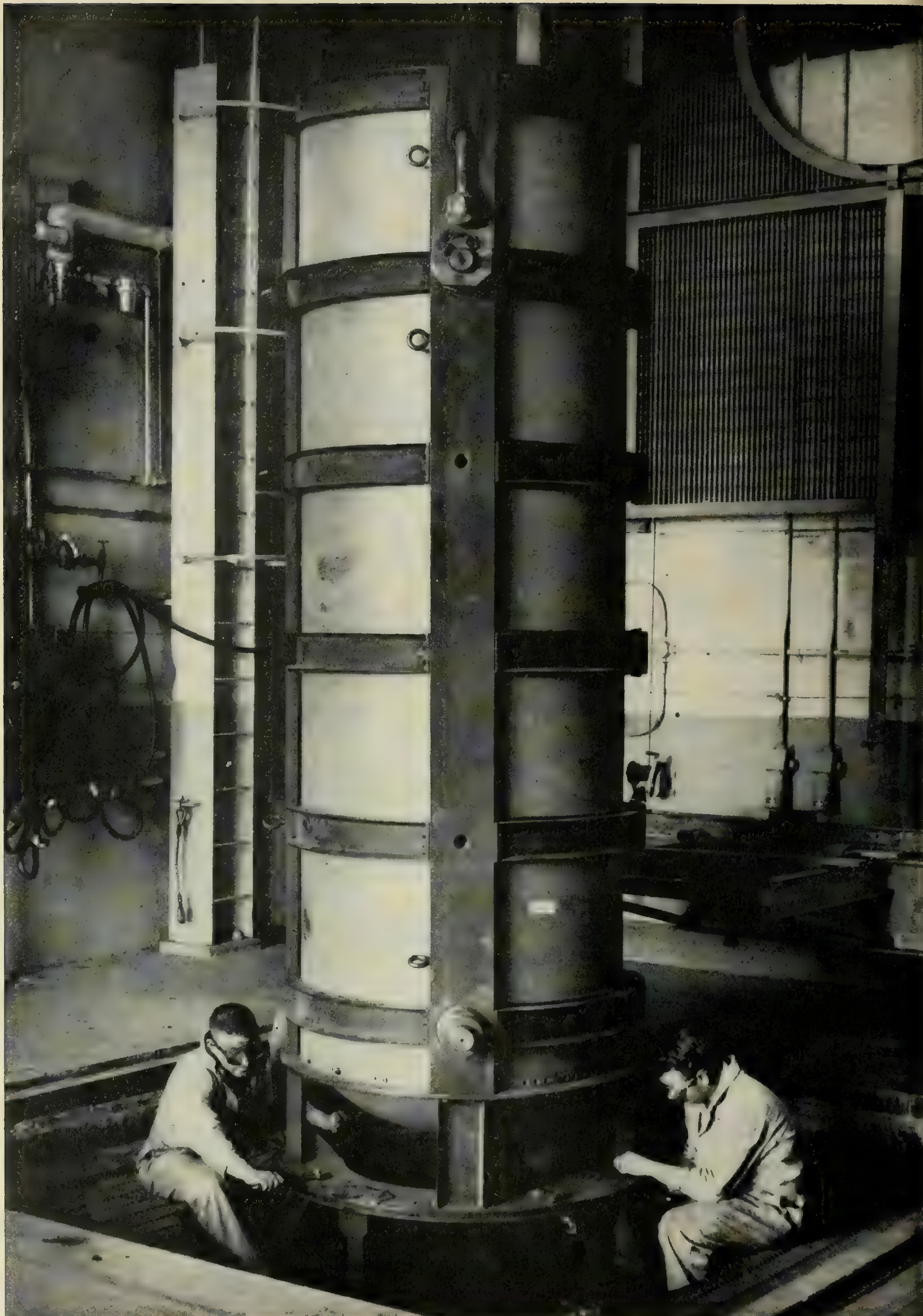
Tom Johnston
Brown & Butcher, Inc.,
Advertising
New York, N. Y.
for Thiokol Chemical Corp.

Cubic's *Mercury* System

To the Editor:

In the Feb. 22 M/R you published a story regarding the Underwood-Canoga contract for antennas for Project *Mercury* ground-based telemetry, communications and command control. Actually, Underwood-Canoga, in supplying antennas for the program, is a subcontractor to Cubic Corporation, which is furnishing its AGAVE tracking system for the around-the-world task of radar acquisition and communication link with the space capsule. Our department did a general release at the time the contract was received (from Bendix), but we neglected to do a proper follow-up.

Bill Sunday
Public Relations Director
Cubic Corporation
San Diego



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We have called upon the electronics industry whose art is instrumentation for the delicate devices required for precise testing and production controls.

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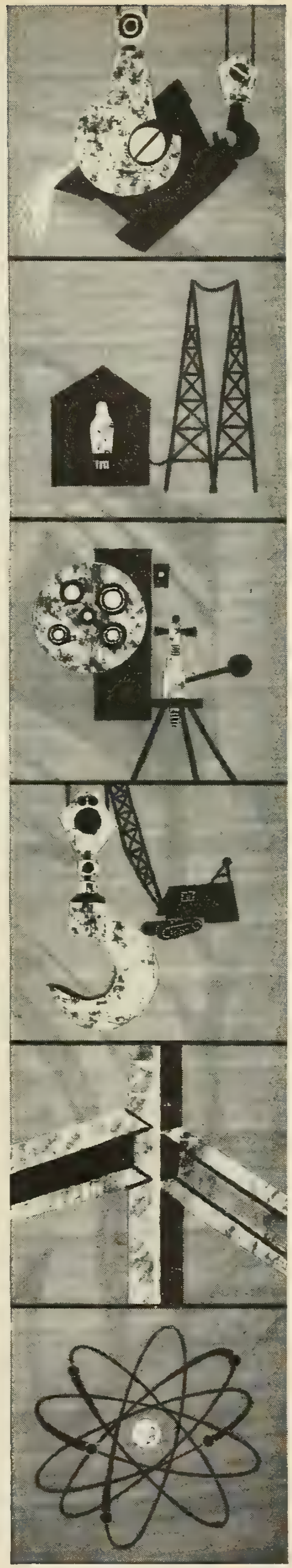
Many industrial technologies are met in a rocket propulsion system. Recognizing this, THIOKOL calls on specialists to achieve highest reliability, to meet the critical rocket power requirements of national defense and space research.



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The Countdown

WASHINGTON

ubroc May be Scrapped for *Aster*

Serious development problems reportedly have hit *Subroc*, the Navy's 25-50-mile-range underwater or surface-to-underwater missile. The trouble lies mostly in conversion to surface launch. COUNTDOWN has learned the Navy is seeking a replacement by marrying the *Asroc* torpedo to the *Terrier* antiaircraft missile. Applied Physics Lab, Vitro and Ford Instrument are working on the new missile—called *Aster* (not to be confused with Westinghouse's *Astor* rocket torpedo). *Aster* would have 30-35 mile range, with the torpedo dropping away from *Terrier* carrier rocket over the target.

Hottest Issue: *Polaris* Subs

Insiders are saying the Mahon House Military Appropriations Subcommittee is getting ready to vote more construction money for *Polaris* submarines—at least six instead of the three in the Eisenhower budget. The decision will come late this month. Though the Administration said it would up funds for long leadtime items from three to nine subs, the feeling in Congress is that three more subs in hand are worth nine in the bush.

Sea Launcher for *Minuteman*

The Air Force is believed to be getting ready to spring a new type of submersible launcher for *Minuteman* on the Navy in the continuing fight over fixed and mobile sites. A proposal is being advanced, COUNTDOWN is told, to put the missiles in platforms similar to Texas Towers. The platforms would be able to move beneath the surface of the ocean—or maybe lakes. At the time of launch legs would be lowered to the ocean floor and the platform would rise to surface to fire the birds from tubes.

First Capsule Abort Shot

First of two NASA shots coming next month will attempt the first abort of an operational *Mercury* capsule (unmanned) at Wallops Island on May 4. It will be a pad abort triggered by the escape rockets. On May 5, the first attempt to orbit a 100-ft. *Echo* passive communications satellite will be made with a *Thor-Delta* at Cape Canaveral, if all goes according to schedule.

INDUSTRY

Vitro Drops $200,000 on Proposal

Latest victim of the high cost of military contract proposals is Vitro Laboratories. The company is reported to have spent $200,000 in an unsuccessful bid for the Fort Huachuca, Ariz., electronic range. Pan American won the contract, expected to run to $40 million.

Boeing, Westinghouse Boost ASW

Major drive for ASW business is quietly under way at Boeing Aircraft, which is said to have spent about $750,000 building in-house capability . . . In a move to strengthen its ASW effort, Westinghouse has appointed Adm. L. J. Down (USN-Ret.) as staff assistant for ASW Activities, a new position in the company's Defense Products Group. Down has been with the company since 1957.

Excuse for the Arsenal?

The Army is quietly boasting that its Rock Island, Ill., arsenal is bringing in the *Davy Crockett* bazooka-type nuclear-warhead missile with just three years lead-time. The first operational type *Crocketts* are already available for demonstration firings. Some Army R&D men are contending industry couldn't have done the job this fast.

AF Halves Propulsion Dollar

Liquid fuels are far from dead in the Air Force research book, though solids are gaining. Of $23.6 million for rocket R&D in the 1961 budget, the AF is asking $11.4 million for liquids and $12.2 million for solid-rocket technology.

Titan Base-Building Pushed

Sites for only four more *Titan* squadrons remain to be selected. The Air Force has named Davis-Monthan AFB, Tucson, Ariz., and McConnell AFB, Wichita, Kan., as locations for two squadrons each. This brings to ten the number of squadrons—all underground—either ready or being built. Cost of the last two facilities will be $80 million apiece.

INTERNATIONAL

Soviet 50-60 Pad ICBM Base

Reports seeping under the Iron Curtain have the Russians constructing one of their largest ICBM bases at Semipalatinsk, at the western edge of the Kazakh Uplands. Many of the 50 to 60 pads are complete, so the reports go, and all of them are "soft" above-ground launchers.

Red Chinese Satellite Shot

Round-about word reaching Washington, and thought to be reliable, says Red China is preparing for a satellite launching within 10 months.

French Eye *Polaris*

The French are reported considering cancellation of their land-based IRBM, which is still in the development stage, if they can procure *Polaris* missiles. Like the British, the French favor deployment of long-range missiles on mobile platforms, either submarines or barges.

For Technical Countdown, See Page 29

Twelve-foot diameter dish of WSR-57 "Stormfinder" radar. System operates at S band, has 250-mile range, 500 Kw output.

Now being delivered to the U. S. Weather Bureau are WSR-57 weather detection radars. Each unit covers 200,000 square miles, tracks storms, identifies rain, snow and fog. This equipment is designed and produced by Raytheon.

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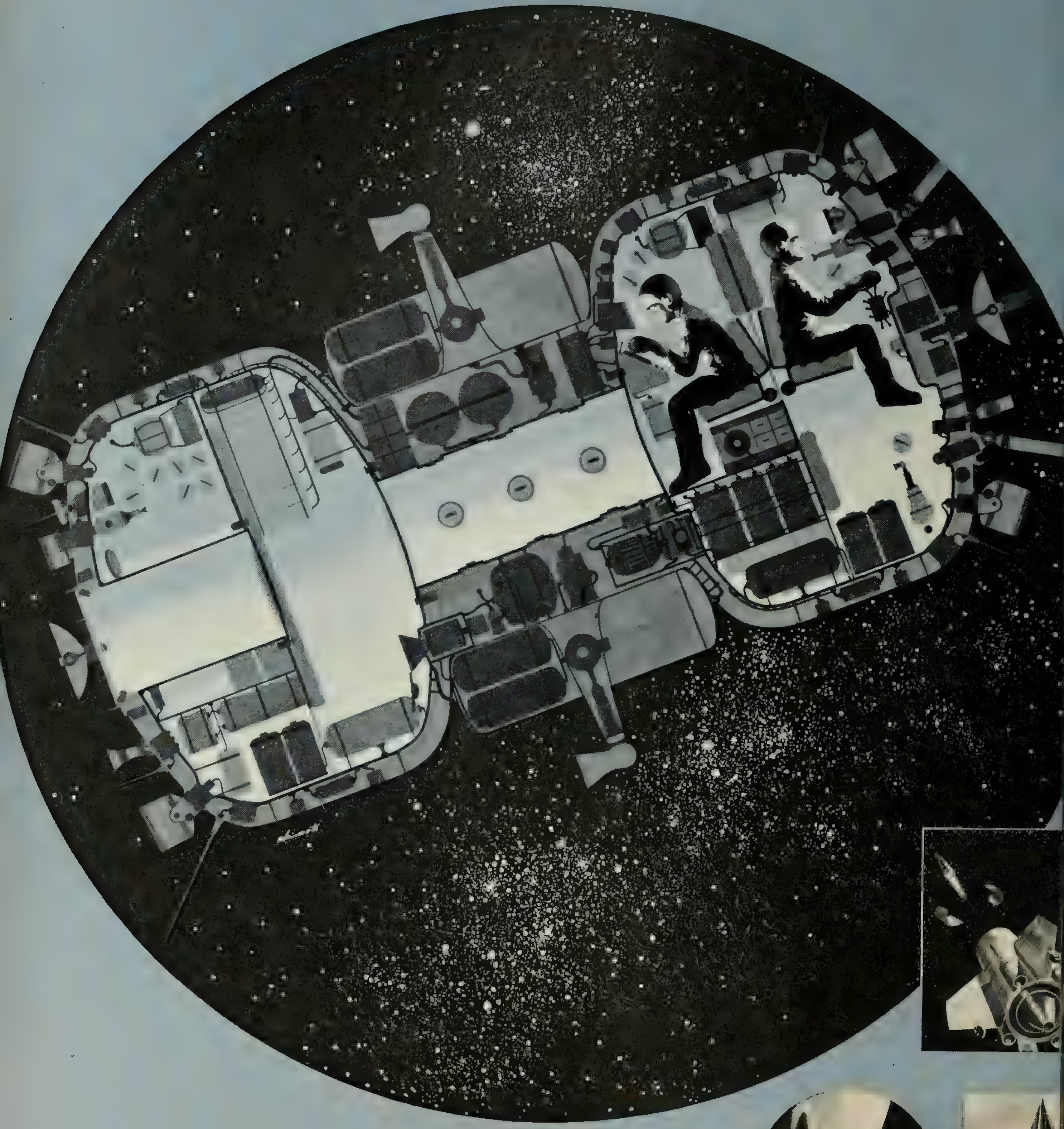
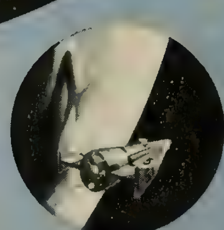
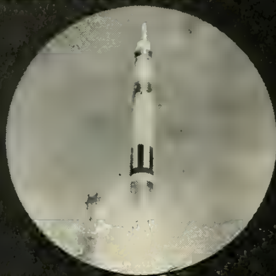




CAREER OPPORTUNITIES AT ATLANTIC MISSILE RANGE AND FORT HUACHUCA



Service to scientific exploration has been performed by the Guided Missiles Range Division of Pan American World Airways since 1953.

Pan American has prime responsibility for the engineering, operation and maintenance of the Air Force Missile Test Center's 5,000 mile Atlantic Missile Range beginning at Cape Canaveral.

Now, having been awarded a prime contract by the Army Signal Corps, Pan Am has the new responsibility for engineering and operating an Electronic Environmental Test Facility near Fort Huachuca, Arizona. Fort Huachuca will be the brain center of the Test Facility, where information gathered in the field will be analyzed in the Army's automatic data processing facilities, among the most modern and complete in the world.

Additionally, Pan Am will engineer, install, operate and maintain facilities for a test range for Army drone aircraft, with drone flights to be monitored by radars, telemetry, and optical equipments.

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  - Telemetry
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  - Optics

To investigate career opportunities with Pan Am at the Atlantic Missile Range, contact J. B. Appledorn, Dept. B-18, Guided Missiles Range Division, Patrick AFB, Florida; or at Fort Huachuca, contact C. A. Hodgins, Dept. B-18, 1535 East Broadway, Tucson, Arizona.

PAN AM

GUIDED MISSILES RANGE DIVISION

PATRICK AIR FORCE BASE, FLORIDA

3M Materials Memo

News of materiel for the aerospace industry—from the 27,000 products of the 3M Company

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Armed with these remarkable properties and your imagination, even the sky's no limit for you and 4222. For more information, either check below or see your ELECTRICAL PRODUCTS representative.

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"CODIT" has been "showing up" on the electrical connectors in many of today's missile systems. A quick glance with a portable light shows you in an instant whether these vital connections have been properly made. Even the security people are praising the virtues of "CODIT" in its ability to quickly show whether enclosures are open or closed, fences have been cut, or a piece of equipment has been moved or taken from a storage area.

"CODIT's" suspension of special reflective elements in a solvent dispersed vehicle returns light directly back to its source about 60 times as bright as any white paint could. Furthermore, it reflects at all angles, too. You still get reflectance when your viewing angle is almost 90° with respect to the normal of the coated surface. This is particularly important on rounded or complex shapes.

"CODIT" can be applied by spraying, brushing, hand rolling, or silk screen printing to most clean, dry surfaces. It even takes concrete, rough metal, and wood in its stride. Having a durability comparable to a high grade of exterior enamel, it can be used for exterior applications provided the surface is weatherproof or suitably treated. There is more information to be had from your REFLECTIVE PRODUCTS representative or clip the coupon below.

■ THE HOLE STORY

Want to know what's in a missile? Chances are you can find out from a "Filmsort" Aperture Card, a product of THE FILMSORT COMPANY, one of the divisions of 3M. The engineering drawings for the components of a missile go into these "Filmsort" Aperture Cards. It's no trick to put an engineering drawing as big as 34 x 44" into a standard punch card. All you do is microfilm the 34 x 44" drawing first. The "Filmsort" Aperture Card is simply the winning combination of microfilm and punch cards.

What does The Filmsort Company do? It produces the aperture cards that make microfilm standard, simple and practical.

Several agencies and their prime contractors for missile systems use these "Filmsort" Aperture Cards to keep up with the pace of the space age. These cards have something to do with time – not the time in space, but the time in our everyday world. Seems that in less than 90 seconds, you can put your hands on any one of these cards out of thousands in a file. Then, simply take the "Filmsort" Aperture Card to the *Thermo-Fax* "Filmac 200" Reader-Printer. Now, you can take a look . . . or, take more than a look, take a copy. That's all it takes to get a print these days.

If you'd like to learn more about these "Filmsort" Aperture Cards and expect to be in New York April 19-21, see a demonstration at the National Microfilm Convention in the Statler-Hilton Hotel. If you're chained to the desk then The Filmsort Company will be glad to send you the hole story if you'll so indicate below.

■ ABOUT "MIL"

3M's Missile Industry Liaison is a service staffed by technical personnel experienced in rocket propulsion and other phases of space technology. Their job is to translate problems of the aerospace industry to those 3M specialists best qualified to solve them. If you have questions on any of the items mentioned here, or would like to know what else 3M makes—or could make —for your needs, mail coupon.

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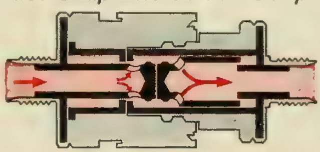

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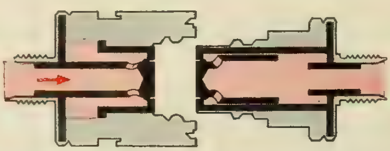

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Snap-Tite's 15 Series valved coupling contains valves in both sections. Thus, the only fluid lost is that which clings to the outer metal surfaces. This coupling meets military specifications and can be used with fuels and other fluids to 3000 psi working pressure and 400°F. Sizes: ¼", ½", ¾", 1" in 6061T6 aluminum anodized; ⅜" in steel (electroless nickel plated), and 6061T6 aluminum.

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House Fights Over DOD-in-Space

by James Baar

Members of the House Space Committee have plunged into a backstage fight over whether the military should be given a bigger role in space at the expense of the expanding National Aeronautics and Space Administration.

The principal target of some members: President Eisenhower's repeated insistence that the military has no business in space beyond a few hundred miles.

The Committee scheduled a series of closed-door meetings this week to act on a series of Eisenhower-proposed amendments to the National Space Act.

Committee members are sharply divided over whether the amendments go far enough in clarifying the Pentagon's space role. Some contend that the present division of space activities between the Pentagon and NASA needs only the minor adjustments included in the amendments. Others contend that much greater changes are needed or the nation's defenses will suffer in the coming decade.

• **Watch McCormack**—House Majority Leader John W. McCormack (D-Mass.), a top-ranking Democrat on the committee, looms as a principal factor in which way the committee vote will go.

The shrewd, white-haired Democratic leader is known to have been concerned for months about the growing operations of NASA in space as opposed to the shrinking activities of the military services. His influence could easily swing enough votes to insert a tough military clause in the Space Act.

The key part of the proposed amendments is Section 309. It says:

"Nothing in this act shall preclude the Department of Defense from undertaking such activities involving the utilization of space as may be necessary for the defense of the United States, including the developing of weapons systems utilizing space vehicles and the conduct of supporting research connected therewith.

"In order to accomplish the most efficient utilization of resources, responsibility for the development of each new launch vehicle whether intended for use by (NASA) or the Department of Defense or both, shall be assigned by the President to either (NASA) or the Department of Defense."

Critics charge that the Section 309 in plain English means that the Pentagon can expand its activities in space if the Administration gives it permission to do it. And, they add, the Administration has no intention of doing it.

• **WW II approach?**—Rep. B. F. Sisk (D-Calif.), another high-ranking member of the Space Committee, says "it is imperative that the Defense Department not be hamstrung" in developing space weapons.

"The President is still living back in World War II," Sisk said. "This is not a partisan matter. Everyone who is living with this situation day by day, all of the top military research men coming before our committee, disagree with the President.

"The Space Act should be amended to upgrade the Defense Department's space role."

• **Ike defended**—However, Rep. James G. Fulton (R-Pa.), another high-ranking committee member, contends the best thing that can be done for the Space Act is "to make it less rigid."

"The President's amendments are good because they allow room for more give and take," he said. "Both NASA and the Pentagon have important roles in space and if they overlap that's all to the good."

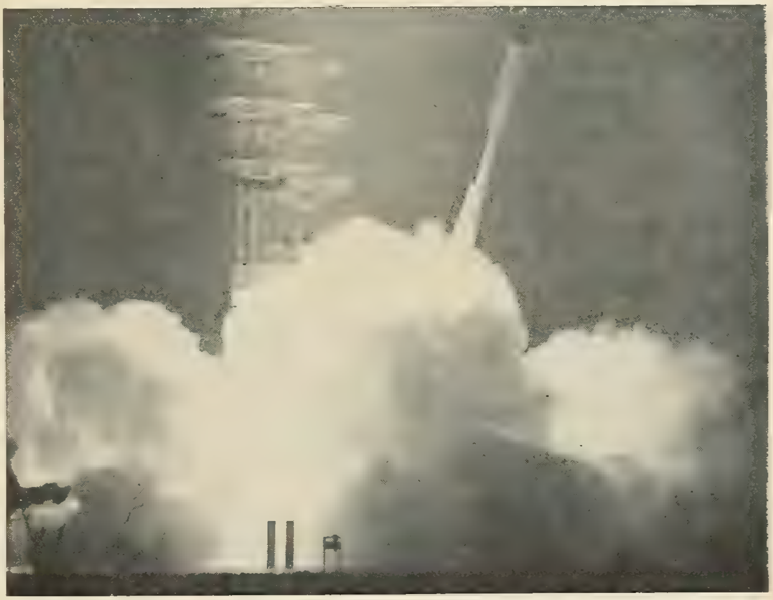
He disagreed that the amendments would shortchange the military, even if NASA developed all of the nation's big boosters.

"That's strictly a matter of procurement," he said.

Military officials violently disagree. They contend that forcing them to go to NASA for boosters cripples military space programs. They say that such an arrangement results in not getting the kind of boosters they want or the number they want when they want them.

This is the heart of the dilemma before the Space Committee.

First Scout Gets Off—Fails



NASA launched the first test model of the solid-propellant *Scout* four-stage satellite launching vehicle from Wallops Island, Va., April 18, with mixed results.

Only the Aerojet 100,000-lb.-thrust *Algol* first stage and the Hercules 10,000-lb.-thrust *Antares* third stage were tested. The *Algol* functioned successfully, lifting the vehicle to an altitude of 30 miles and about 80 miles out over the Atlantic. The *Antares* motor failed to ignite.

The second-stage *Castor* engine by Thiokol and the fourth-stage X-248 *Altair* engine were not used because they already have been flown.

Aerojet said the *Algol*, which burned about 40 seconds, was the largest solid rocket ever flown. It is a modified *Polaris* test vehicle, with a single nozzle instead of four.

production delay . . .

Mobile *Polaris* for Britain Will Take 15-Month Minimum

Even if it acts quickly, Britain faces a wait of at least 15 months in obtaining mobile-based *Polaris* missiles to replace its cancelled *Blue Streak* IRBM, M/R has learned.

The time lapse will be even longer—four years—for the *Skybolt* air-launched ballistic missile, which is still under development.

There is likelihood that there will be a delay of several months before any extra production of *Polaris* is authorized. The United States, rather than sell *Polaris* directly to Britain, wants the British to procure it through NATO.

There was speculation that France also may want to buy *Polaris*. This could further complicate the funding and build in more delay in stepping up production.

Authoritative sources gave this timetable for producing operational *Polaris* missiles (assuming sufficient funding) for allies:

- On land-based fixed-site launchers—minimum of 11 months.
- On barges, railroad flatcars, or trucks—minimum of 15 months.
- Aboard submarines—minimum of 46 months (nuclear power reactors for subs have a leadtime of more than 40 months).

The British probably would build their own type of fleet ballistic missile submarines. But they could be expected to equip them with many U.S. systems integral with the missile, i.e. launchers, fire control and inertial navigation.

British Defense Minister Harold Watkinson, who ordered cancellation of the fixed-base *Blue Streak*, is due in the United States late next month or in June. He is understood to be under pressure from the Royal Air Force to buy the Douglas *Skybolt*.

However, *Polaris* will be operational with the U.S. Navy this year and its earlier availability undoubtedly will influence the British decision.

Blue Streak Out

Industry Will Suffer; *Bloodhound* May Follow

by G. V. E. Thompson

LONDON—Heavy layoffs in the British missile industry are expected to follow the Macmillan government's decision to cancel the 2500-mile *Blue Streak* missile. Dropping of the *Bloodhound* Mark III antiaircraft missile appear imminent.

Companies immediately affected are de Havilland Propellers, the main contractor; Sperry Gyroscope, the guidance package; and Rolls Royce, which is making the motor under license from Rocketdyne.

Extent of the layoffs may be made known this week when Parliament begins debate on a Labour Party motion to censure the government for not cancelling the program sooner.

The government has spent $180 million to date on the *Blue Streak*. But when contract commitments have been settled the figure will amount to $280 million. The project had been expected to cost between $1.4 billion and $1.7 billion.

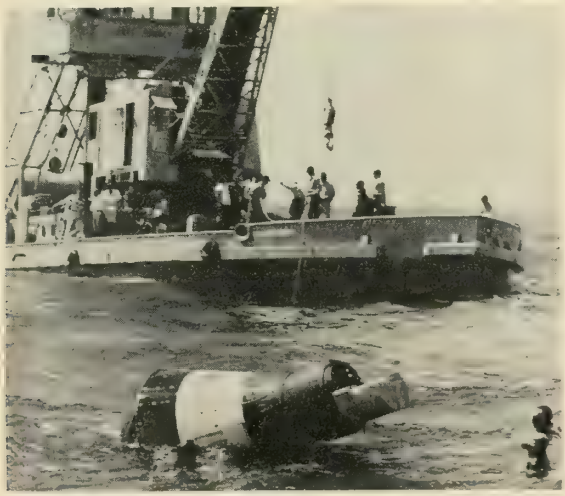
A slight hope remained that the Government may decide to use the *Blue Streak* for space research. But this would require only about $56 million in funding.

And even this sum may be considered too high. The whole question has been referred to Lord Hailsham, Minister for Science, who is not a scientist. The Committee which advises him has already indicated it is not favorably inclined toward space research.

• **Emigration**—Accordingly, a number of design engineers, lacking opportunities in their field, may decide to leave Britain for some other country—possibly the United States—where they can remain in rocketry. Some American companies were understood to be actively recruiting top missile engineers in the affected plants.

The cancellation created further repercussions in Australia, where the Australian Government has spent $200 million on the Woomera rocket range, including many special facilities for the *Blue Streak*.

Astronaut's Escape at Sea—Capsule Squeeze Play



RISK OF DROWNING will be high for the *Mercury* astronaut who attempts to leave his capsule at sea. Series of photos taken during training at Pensacola, Fla., show the problem in wriggling out of the small container. After removing his restraining belt, unshackling his oxygen hose and removing the pins from the instrument panel to push it aside, the astronaut then can open the pressure

Democrats Undercut Own Space Issue

For the second straight year, a Congress controlled by Democrats has started to undercut one of the party's major campaign issues by chopping the nation's space budget.

Though many Democratic Congressional leaders—including Senate Majority Leader Lyndon Johnson—have criticized the nation's space program as being underfunded, the House Independent Offices Appropriations Committee, chaired by Rep. Albert Thomas (D-Tex.), again recommended that NASA's budget be cut.

Last week, the full House approved the cuts without changes.

Last year, when Democrats were screaming about the inadequate space program, Thomas and his associates lopped $45.5 million off NASA's supplemental '59 and FY '60 money requests. (See M/R, July 13, '59, p. 11). Congress approved most of the cuts.

• **Senate crossed**—This year, with the space program looming as a major campaign issue, Thomas's subcommittee recommended that the House slash NASA's '61 authorization request by $38,985,000. The move came at a time when Democrats on the Senate Space Committee are recommending that NASA's budget be increased $30 million.

The Thomas Committee bill (H.R. 11776) cuts NASA's FY '61 research and development budget by $19,213,000, the construction and equipment budget by $15,512,000, and the salaries and equipment budget by $4,260,000.

Programs cut in the NASA R&D budget included in-house R&D support, research grants and contracts, sounding rockets, scientific satellites, meteorological and communications satellites, Project *Mercury,* vehicle systems technology, and tracking and data acquisition.

Major R&D cuts were $5 million from research grants, a "token cut" of $2.75 million from Project *Mercury,* $3.1 million from the scientific, meteorological and communications satellite program, and $1.5 million from the tracking and data acquisition program, most of which would have gone for the *Mercury* world-wide tracking fence.

• **Standing pat**—Major cut in the construction and equipment budget was $6,563,000 for construction of new facilities, at NASA's newly acquired George C. Marshall Research Center at Huntsville. The money, which would have been used to build a central laboratory and office facility, complete the guidance and control building, and add a new wing to the fabrication laboratory, was not considered "essential . . . to the fine plant that is now operating satisfactorily."

The salaries and equipment budget was cut by a reduction of 373 positions in the number of new personnel NASA wanted to hire. The new personnel would have been employed at Huntsville, the new Goddard Center, Wallops, and at NASA's Washington headquarters.

Heading Off Aerojet?

Two competitors for the Air Force's Project 3059 big solid-fueled booster reportedly submitted a last-minute joint bid in an attempt to head off award of the contract to Aerojet-General. Air Force Undersecretary Joseph Charyk will make a facilities inspection trip to the West Coast this week, prior to announcing the winner.

Bendix Gets $21 Million For More Work on *Eagle*

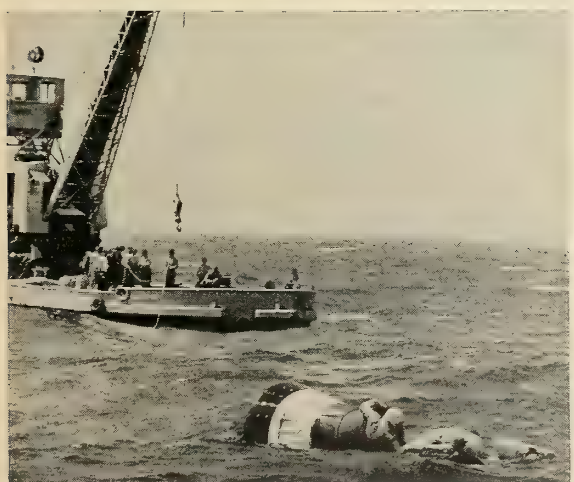
Bendix Aviation, Detroit, last week was awarded a $21-million Navy contract for continued development and evaluation of the *Eagle* air-to-air long-range missile. The new contract is in addition to the research and development contract previously given Bendix.

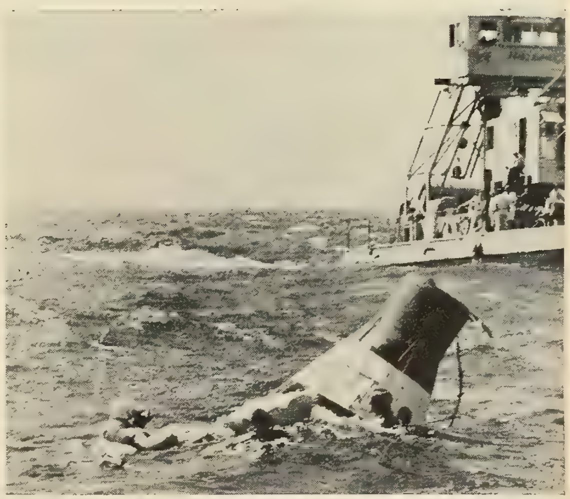
Douglas Chooses Burton As New Engineering Chief

Douglas Aircraft Company has tapped Edward F. Burton to succeed retiring Arthur E. Raymond as senior vice president-engineering.

Burton, with Douglas for 35 years, had been vice president-Engineering.

Moving into new positions as Burton's assistants are Elmer P. Wheaton, who will be responsible for technical affairs, and R. L. Hoskinson, who will assist in administrative matters.





hatch at the top of the capsule. Procedure calls for first ejecting the empty parachute can (far left) and then pulling himself upward through the bobbing 16-by-32-in. opening. All of the seven astronauts have found the feat extremely difficult—even with the help of frogmen. *Mercury* project officers decided that the first one to return from space into the sea should try to leave only in emergency.

Horner Defends Present Space Setup

Outgoing NASA Assistant Administrator Feels Civilian Space Program Has Secure Future

by Paul Means

Richard E. Horner, who will leave his position as Assistant Administrator of NASA for a position in industry this summer, outlined for M/R last week his appraisal of the U.S. space program —how it got that way and where it is going.

(Horner has not yet made a public announcement of his plans to resign, which were reported exclusively by M/R April 11.)

Giving the type of studied, comprehensive answers to questions that made him a favorite witness before Congressional committees, Horner:

- Defended the present U.S. space organizational setup, even though admitting the reasons for a civilian space agency may have been illusory at the time NASA was set up.
- Criticized those who would "turn back the clock" and put the entire space program under the Department of Defense, stating that such action would waste a lot of time and money.
- Reported that liaison between the civilian and military space programs is good, and will get better as NASA becomes more organized and moves into its permanent headquarters.
- Felt that too much time is wasted by top NASA personnel testifying before Congress, and suggested that Congress might consider the formation of a joint space committee similar to the Joint Committee on Atomic Energy.
- Predicted that the U.S.'s comprehensive space program will produce more real results than the Soviet program in the not-too-distant future.
- Believed that the most important product of the space program during the next ten years will be technological advancement and its application to all phases of U.S. industry.

Horner came to his NASA post almost 11 months ago after two decades as an Air Force officer and administrator. A decorated pilot in World War II, Horner has been technical director of the AF Flight Test Center at Edwards AFB, Calif., deputy for requirements to the Assistant Secretary of the Air Force for R&D, and Assistant Secretary of the Air Force for R&D.

• **No return**—In answer to the question whether NASA should have been created in the first place and whether the civilian agency should have all of the projects now under its direction, Horner reminded that "you can never turn the book back . . . it is one thing to ask what you would do today, and another about how one would have done it yesterday."

NASA was set up, according to Horner, for the "rather sketchy abstract reason that it was the nation's intent to have a peaceful program for peaceful purposes benefitting mankind, and therefore we had to have a civilian agency."

He pointed out that the Department of Defense had carried out peaceful space programs before NASA was formed, and that "present NASA projects have military applications and present DOD projects have civilian applications . . . it is difficult to explain to everybody's satisfaction the difference between civilian and military space programs."

RICHARD E. HORNER, who will leave NASA for a post in industry this summer.

• **DOD snafu**—The underlying reason NASA was set up, Horner thinks, is that the American people have an "aversion to handing something over to the military" during a time of peace, and because of "malorganization in DOD during that period."

Horner believes that "if DOD had been organized as well in 1957 as it is now, there might not have been a NASA."

He added that the present organization can work and will work with proper liaison, and that it would be much better for the nation to go ahead under the present organizational set-up than to tear it down and start all over again.

Horner is satisfied that NASA and DOD have found the right technique to correlate their efforts. This technique, according to Horner, calls for "lateral exchanges of information liaison at all levels."

The Holaday Military-Civilian Liaison Committee did not work, according to Horner, because it had "no responsibility and no authority."

In order for such a liaison committee to operate effectively, Horner believes, it "must incorporate the management authority of both organizations."

This creates, Horner thinks, a difficult problem: "how do the Secretary of Defense and the Administrator of NASA share their authority and responsibility with a third party?"

• **Lateral liaison**—Lateral liaison at all levels, Horner predicts, will become more effective when "more confidence is demonstrated in the space program personnel—that they are doing the right thing—by all of their associates in government," and when "NASA begins to give a better display of their ideas to the military, Congress and industry."

The first problem is being minimized, Horner believes, with each new successful launch. "The therapeutic effect of each successful launch is the enthusiasm of important people in government who now see space is useful."

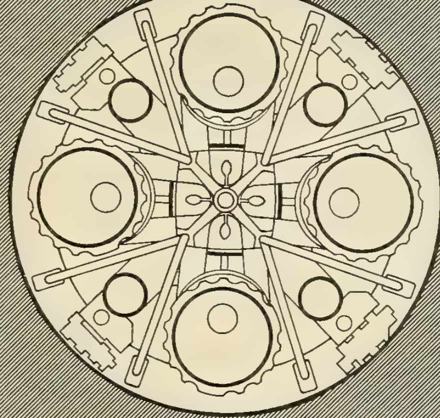
The second problem has been somewhat neglected by NASA, Horner admits, because "we have been too busy organizing." It will be eased with the completion of NASA's program management control center on which Horner presently is hard at work.

• **Control center**—The center, which will be similar to the General Services Administration's program management center and the Navy's *Polaris* program control center, "will help NASA give focus to its problems both in money and in time."

A makeshift center will be in operation soon, Horner stated, but the more mechanized center cannot be built until NASA moves into its new headquarters next year.

With such a center, Horner predicts, NASA can give better program briefings to DOD, Congress, industry, and

Gamma rocket engine proves its unique reliability in British space probe...



End view showing combustion chambers which can be inclined for vehicle guidance.

...ANOTHER ENGINEERING ADVANCE BY BRISTOL SIDDELEY

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellent rocket engine, the Gamma delivers 16,400-lb thrust (7,438 kg) at sea level rising to 19,000 lb (8,618 kg) outside the earth's atmosphere for a total engine bay weight of under 700 lb.

The Bristol Siddeley Gamma has four gimbal-mounted combustion chambers which are hydraulically actuated for vehicle guidance. Each combustion chamber is fed with propellents by its own turbopump unit and the four units are joined at the centre by a common manifold. The Gamma burns hydrogen peroxide (HTP) with kerosene and uses silver-plated nickel gauze as a catalyst to decompose the HTP into oxygen and superheated steam.

Gamma powers Black Knight. The Bristol Siddeley Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. The Gamma has proved itself to be exceptionally reliable. In fact, in all firings to date Black Knight has never failed to start, and has reached a height of over 500 miles above the Woomera rocket range in Australia.

Since Bristol Siddeley's rocket division began work in 1946 it has developed a wide range of rocket components. By combining these components in single or multi-chamber layouts, thrust requirements from 500 lb up to 100,000 lb. can be met. *For further information please write to Bristol Aero-Industries Limited, 200 International Aviation Building, Montreal 3, Canada. Tel: University 6-5471.*

BRISTOL SIDDELEY ENGINES LIMITED

other organizations participating in the space program, and will produce a "real working liaison, which depends on a common understanding of the facts."

Horner also predicts that NASA's liaison with all groups in the future will be complete, since as a civilian agency "NASA has little to hide."

Horner believes that NASA's relations with Congress also will be smoother with the establishment of the center, which could dispatch requested information, displays, and provide for briefings more adequately and faster than is the case presently.

• **Wasted time**—Though he didn't "feel too strongly about the issue," Horner believed that NASA personnel were presently being asked to spend too much time briefing Congressional Committees.

Horner said he did not dispute Congress' "right to know," but that the same briefings and information sometimes had to be given to as many as four different committees.

One solution that Congress might investigate, according to Horner, is combining the House and Senate Space Committees into a Joint Space Committee similar to the present Joint Committee on Atomic Energy. This way, Horner believes, Congress would get all of the information—and NASA would have to give its authorization requests and briefings only once.

Horner defended NASA's present policy of gearing the U.S. space program to conduct broad research programs rather than concentrating on a few spectacular shots as the Russians have done.

"The nation is understandably fascinated by our 'lift competition' with the USSR, and does not yet recognize the growing problems of making efficient use of our launching capacity."

"It is going to become terribly apparent during the next few years that just being able to lift heavy loads into space will not be enough," he predicted.

• **Future trend**—Horner believes that the tremendous research and development effort in the future will swing away from propulsion and launch vehicles to payloads and spacecraft. "The tremendous research and development effort in that end of the spectrum will make vehicle development seem relatively unimportant."

Space vehicle payloads, he pointed out, are already becoming more complex than military aircraft because of space limitations, environment, difficulty in testing, and expense.

Although vehicles will not change from launch to launch, payloads will. Horner admits that there will be a "generic relationship between payloads—but something like the difference between

the F-86 and the F-100."

For the next few decades in space, Horner foresees no booster shortage, but he does see many advances that must be made in instrumentation before "talking about landing on the moon in ten years becomes believable."

After his experience with the space program both in the Air Force and at NASA, Horner states that he "can't help but be impressed at the useful work going into the space program"—useful, that is, to other phases of American industry.

He is "convinced that the real product of the space program is U.S. technological advancement." One of many examples, Horner believes, is the fact that much of the work done for the space program has miniaturized components, a by-product which is changing the appearance of our radios, TV sets, ice boxes, and industrial automation.

• **Useful post**—Asked about the need for his position in the NASA organization, Horner said he "had worked harder at NASA" than he had in any of his previous jobs.

He described his position as resembling a corporation vice president in charge of operations. Such a position in NASA, Horner believes, is necessary because the "rather diverse internal operation which consists of research laboratories such as Lewis, development operations such as the Marshall Laboratories at Huntsville, contract development operations such as are conducted with JPL, and pure contract operations with industry."

NASA's greatest task, according to Horner, has been to develop a "coherent and energetic operation organization capable of conducting and performing the nation's space aims, and with a strong motivation for meeting schedules which are so important in a hardware development operation."

This has involved, according to Horner, the welding together of the individual activities referred to above into one operational organization. The problem was more difficult, Horner believes, because at the time NASA was reorganizing its inherited NACA organizations such as Langley, Lewis and Ames, it was continually acquiring new organizations such as NRL, JPL and Huntsville.

Horner recognizes that "it has taken considerable time to weld together an organization capable of conducting the U.S. space program." With Congressional and public support, Horner believes, the organization formed—NASA—is not only capable of overtaking the Russians, and providing new technology for industry, but can also effectively aid the DOD military space operation.

Bell Bows Out of Defense Industry

Bell Aircraft Corp. stockholders early in June are expected to approve a $30-million offer from Textron, Inc., for Bell's defense and aircraft business. Equity Corp. of New York, an investment company which holds 51% of Bell's stock, has indicated that it favors sale.

Divisions affected would be Bell's Niagara Frontier division, the Bell Helicopter Corp. of Fort Worth, Tex., and Hydraulic Co. of Burbank, Calif. Bell's aircraft business is estimated to have made profits in excess of $6 million a year before taxes the last five years. Textron, which last year aggregated $308 million with profits of $16.6 million, hopes to add $100 million a year in sales with the purchase.

The divisions would be operated by Textron as an autonomous, wholly-owned subsidiary under the name Bell Aerospace Corp. No immediate change in management is expected in the corporate setup. Bell Chairman Leston Faneuf and President Harvey Gaylord would retain their positions in the new company, with Dr. Walter Dornberger staying on as director of engineering.

The commercial divisions remaining in the Bell Aircraft Corp. would presumably have new corporate management. Divisions are: the Wheelabrator Corp. of Mishawaka, Ind., the W. J. Schoenberger Co. of Cleveland, the Birma Manufacturing Co. and the Lake Erie Machinery Corp. of Buffalo, and Lord Chemical Corp. of York, Pa.

Should the Bell stockholders approve the sale, it will mark Textron's seventh acquisition within 15 months and its 24th since 1955. Textron owns several large electronics companies, and military sales accounted for 13% of its revenue in 1959.

mergers and expansions

Emerson Shifts Defense Work Into New Subsidiary—Emertron

Emerson Radio & Phonograph Corp. has formed a subsidiary, Emertron, Inc., to handle its government and industrial electronics business.

Taking over a $20-million backlog of orders from the parent company, Emertron will develop and produce altimeters, countermeasures devices, missile fuses, flight data recorders and other electronics equipment. Adm. John D. Small, USN (Ret.) will be chairman of the new company, with headquarters in Silver Spring, Md.

THOMPSON RAMO WOOLDRIDGE International Division has been organized to coordinate the company's foreign activities. Subsidiaries already are operating in Brazil and Mexico, and joint ventures are upcoming in Argentina and France. George W. Fenimore, former assistant vice president, will be general manager.

BRUSH BERYLLIUM is doubling the capacity of its principal plant at Elmore, Ohio, to produce vacuum-cast beryllium billets and beryllium hydroxide.

HOFFMAN ELECTRONICS CORP. has started construction of a new Science Center in Santa Barbara, for applied research in industrial electronics and in satellite and anti-submarine warfare systems.

SPACE SYSTEMS LABORATORIES, Burbank, Calif., has been created to provide research, analysis and development services on physical, biological and engineering aspects of space technology. Dr. Morton Alperin, previously Director of Advanced Studies and Aeronautical Sciences for the Air Force Office of Scientific Research, is technical director of the new company.

US STEEL BROKE ground at its Gary Steel Works recently for a new rolling mill expected to produce the widest steel plates in the world. Plates weighing as much as 60,000 lbs. will be available for use in submarines, atomic energy installations and missiles and support equipment.

GARRETT INTERNATIONAL has teamed with German industrialist Hans Liebherr to form Interaero GmbH to manufacture and maintain Garrett product lines in West Germany.

ELGIN NATIONAL WATCH CO. will build a research and engineering plant for Elgin Micronics Division near Palatine, Ill. . . . Acoustica Associates, Inc. is expanding plant space in Los Angeles and Garfield, N.J. . . . Filtron Co., Inc. of Flushing, N.Y., and Culver City, Calif., has established a Palo Alto, Calif., field engineering facility for radio-frequency interference engineering services.

BELOCK'S ASTRO-SPACE LABORATORIES, CORP. has leased an 18,000-sq.-ft. building in Huntsville . . . Wyle Corp. has acquired Burgoyne Testing Laboratories, Inc. in Westbury, N.Y., specializing in environmental simulation . . . Hazeltine Corp., radar-electronics firm, is opening a Washington office . . . Waldorf Electronics and Fluid Systems division of Huyck Corp. changes name to Huyck Systems Co.

Capsule Recovery Foiled When It Fails to Re-enter

The Air Force failed again last week to recover a capsule from an orbiting *Discoverer* satellite. However, a Navy *Transit* transmitter carried for the first time in the satellite itself functioned successfully.

A *Thor* booster placed *Discoverer XI* in a polar 380-109-mile orbit on April 15. The *Agena* second stage ejected the capsule, but it remained in orbit rather than re-enter the atmosphere. The *Transit* transmitter was carried as a backup to the navigation satellite program.

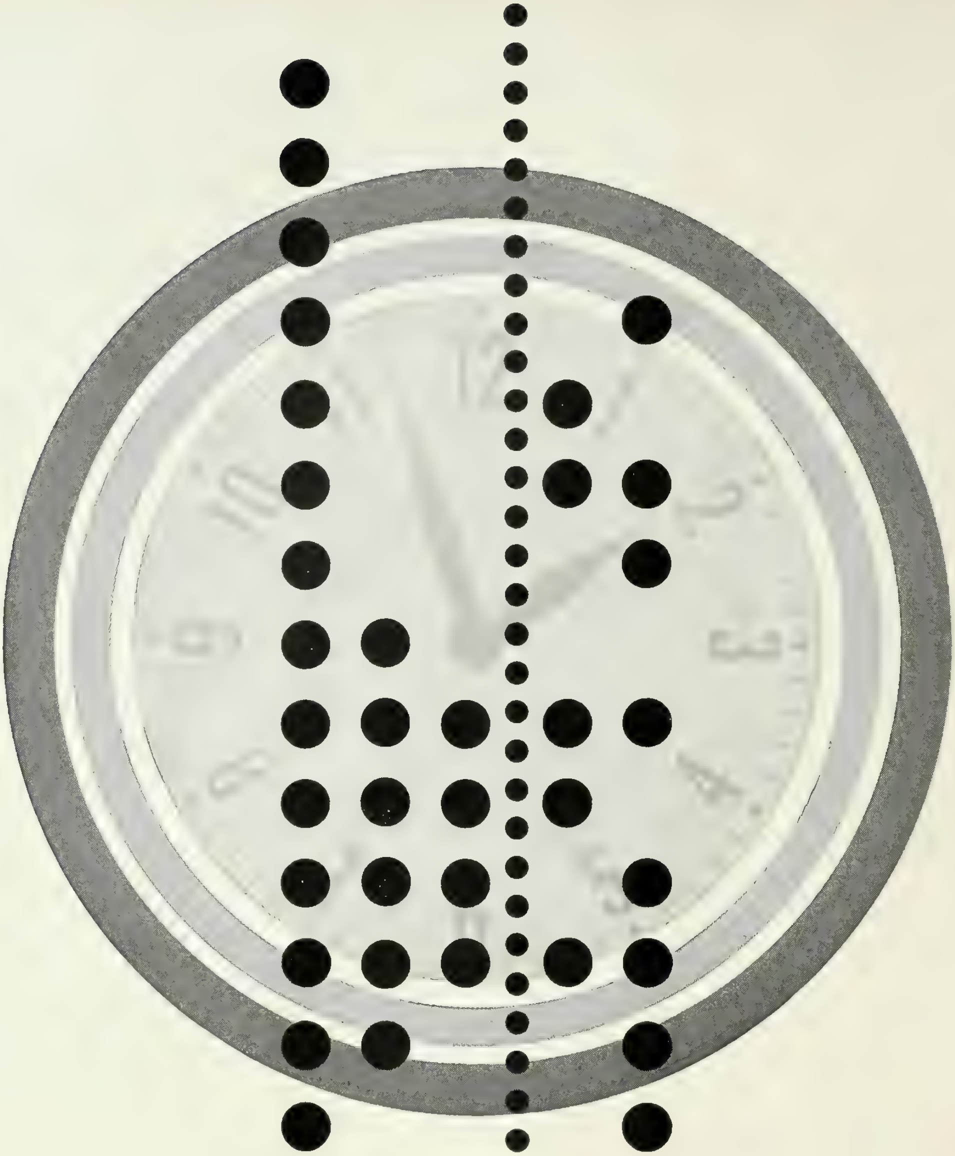
U.S. Contracts to be Topic Of GW Law School Institute

The seventh annual Government Contracts Institute will be held by the George Washington University Law School in Washington, D.C., April 28-29.

The Institute will discuss landmark cases in government contract law during the past year, the recently revised ASPR Section XV and application of its cost principles, proprietary and technical data, and standards of proprietary conduct in dealing with or for the government.

Lacrosse, U.S. Army's most accurate surface-to-surface missile
–developed and produced by Martin

MARTIN



Technical Countdown

ADVANCED MATERIALS

Orbital Environment Lab

Next big selling program in space for major systems contractors should be a manned environmental lab for testing materials, equipment and human engineering. Martin last week jumped on the bandwagon with a proposal at an IAS meeting that such a project is a "technically feasible second-generation space vehicle"—beyond *Mercury* and *Dyna-Soar*—and can be accomplished by 1965. Some specs: 16-ton lab using three-stage *Saturn* for boost into 400-mile orbit; 4-6 man capacity; double shell (beryllium, outer, 5456 aluminum alloy, inner); three compartments separated by aluminum alloy honeycomb bulkheads with airlocks; LOX and nitrogen for atmosphere.

Camouflage for *Atlas* Warhead

Convair has designed an explosive charge which will fragment the final stage of *Atlas*. With pieces spread over several thousand square miles in space, detection by radar of real warhead will be almost impossible.

HF Acid Production Boosted

With national consumption of hydrofluoric acid expected to be 170,000 tons annually by 1965, and a substantial amount going for missilery and space, Dixon Chemical Industries, Inc. is gearing for a big cut of the market. The company is building $3.5 million facility at Paulsboro, N.J., for completion next year with annual 11,000-ton capacity.

Thermionics Spurt Tellurium Market

Tellurium market—small only because it is geared to supply existing markets—is growing because of interest in thermoelectric energy convertors and possibilities of its value as strategic material. U.S. and Canadian producers say production can be raised from 500,000 to 750,000 lbs. annually through existing facilities.

More About Inflation

Dumb-bell-shaped inflatable satellites are being proposed for manned space stations by Martin-Baltimore engineers. They say the station will expand in two directions from the metal canister in which it is launched. The canister will then serve as a rigid center section joining the satellite's two space cabins. The satellite would be erected using the sun as a heat source to expand liquified gas within the vehicle.

ASW ENGINEERING

More Market for Buoys

Dr. John Knauss of Scripps Institute of Oceanography predicts "a vast number" of deep-sea buoys—instrumented for observing water temperature, salinity, density, current velocity, etc.—will be planted in the oceans within a few years. Aim: to provide a better understanding of weather and its prediction through study of heat transfer and circulation of large water masses.

Douglas' JADA

Douglas is developing under a $1.5-million BuWeaps contract an airborne computer system for attack and fighter aircraft. Used by aircraft not normally carrying ASW search and localization equipment, it will be an adjunct to *Julie* sonobuoys.

ELECTRONICS

Mercury Radar Delivered

Cubic Corp. last week delivered the first horizon-to-horizon radar tracking and acquisition unit for *Mercury*. Some 13 AGAVE (automatic gimballed-antenna vectoring equipment) systems will provide surveillance for the vehicles.

PROPULSION

Hercules to Win *Minuteman* Contract

Minuteman third-stage contract will be awarded soon to Hercules Powder Co. Air Force evaluators are reported to be convinced that Hercules double-base propellant, in a fiberglass and plastic case, is not too big a technological step. Aerojet-General, the other competitor, is taking a more conventional approach with a polyurethane-base propellant in a metal case.

Linde Lifts LOX Output

Linde Co. is increasing its oxygen-producing capacity by 4000 tons a day in a $50-million expansion of plant facilities over the next year. Expansion amounts to more than 20% of the total presently installed U.S. production capacity for oxygen. While much of the new facilities will primarily serve steel and chemical industries, Linde is building plants with total daily capacity of 450 tons of liquid oxygen or nitrogen at Huntsville, Ala., Neosho, Mo., and Fontana, Calif., for missile/-space requirements.

Polaris Has Stage Limitation

Regardless of possible short-range mission, both *Polaris* stages must ignite. Thrust termination is on second stage only, since forward bulkhead of first stage has no blowout ports to cut thrust component to zero.

$400,000 for Plug Nozzle

The General Electric plug-nozzle engine will receive about $400,000 of NASA's advanced engine design money in FY '61, about the same as this year. Other projects will share the $4.3 million of advanced design money although testimony of Deputy Administrator Hugh L. Dryden before House Appropriations Subcommittee was interpreted as meaning plug-nozzle would get all.

Liquid H_2 to cost 25¢/lb.

Liquid hydrogen will cost about 25 cents per lb. when delivered in large quantity for testing high-energy *Saturn* upper stages, Dr. Abe Silverstein, NASA Space Flight Programs Director, estimated before the House Appropriations Subcommittee.

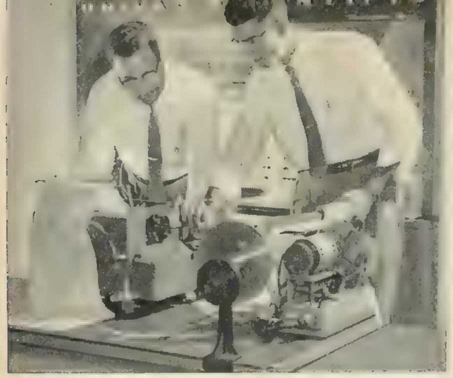
Polaris Gamma Tested

High-energy gamma rays, from a Cobalt 60 source, are being used to check *Polaris* motors for cracks, bubbles and fissures in the fuel and for imperfect bonding of propellant to the case. Rucker Co., Oakland, Calif., installed the test system at Aerojet-General's Sacramento solid rocket plant.

SPACE MEDICINE

Look, Ma, No Cavities!

AF's announced plans to spend $30,000 in FY '61 to study reaction of astronauts' dental fillings to space flight stresses, brought a quip from Rep. George Mahon (D-Tex.) last week that the money could be more effectively used for ASW work.



The Univac Scientific computer is used to simulate and prove the projected design of new systems. This concept of mechanized design, which may be described as the use of one computer to build another, eliminates prototype building and attains a degree of reliability once regarded as only theoretically possible.

From the **REMINGTON RAND UNIVAC**

Military Division

Mechanized Design Dramatically Speeds Development and Increases the Reliability of New Data Processing Systems

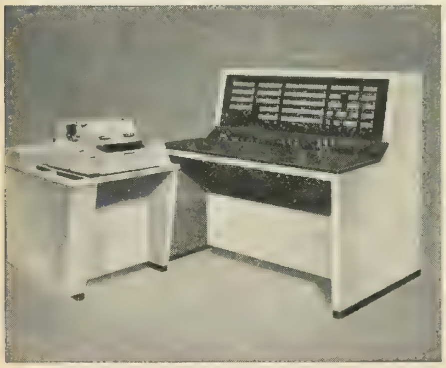
A technician follows the wiring diagram produced by the Univac Scientific. This application of mechanized design greatly facilitates the production of reliable automatic data processing equipment.

Remington Rand Univac was the first to apply the concept of mechanized design to computer development. By using the Univa Scientific computer, the design of a projected system can be fully simulated and proved—thus avoiding the expensive, time-consuming process of prototype building.

This important technique has already made indispensable contributions to the development of such systems as the Univac LARC and Athena and the Univac Advanced Navy computer. Mechanized design has significantly aided Univac scientists and engineers in attaining the farthest limits of reliability, even under the most demanding environmental conditions.

The Military Division's tradition of excellen is firmly established by a distinguished series of defense systems. Mechanized design is another example of the outstanding capabilitie which Remington Rand Univac can bring to bear on the development and production of complex computer equipment for military applications.

UNIVAC®



A significant achievement of mechanized design is the BOGART computer, produced by Remington Rand Univac, for the U.S. Navy. Intensive preliminary testing of the projected system made it possible to reduce the size of the computer while materially increasing its reliability through the use of transistors and printed circuitry.

Remington Rand
UNIVAC
DIVISION OF SPERRY RAND CORPORATIO
Univac Park, St. Paul 16, Minnesota

Control and data systems developed by the Remington Rand Univac Military Division include:

ATHENA, the Ground Guidance Computer for the U.S. Air Force ICBM TITAN.

TACS AN/TSQ-13 (Tactical Air Control System for the U. S. Air Force)

BOMARC Computer for the U. S. Air Force Target Intercept Program

SEA SURVEILLANCE SYSTEM FOR THE U. S. NAVY

AN/USQ-20 (Advanced Computer for the U. S. Navy)

Additional information describing capabilities and experience or career opportunities may be obtained by writing to Remington Rand Univac at the above address.

Autolite Enters Missile/Space Field

Old-line automotive firm wants to diversify and reap advantages of present R&D in hydraulics, ceremics

by William Beller

An M/R Management Engineering Feature

TOLEDO—Another old-line industrial company is entering the lists for missile-type contracts. This is The Electric Autolite Company, world's largest independent manufacturer of automotive electrical equipment. Its experience related to the missile field is in ceramics, hydraulics, acoustics, pneumatics and plastics.

To diversify and also get the advantage of the research and development work it has been doing in connection with its automotive line, Autolite late last month set up a Special Products and Research and Development Division (SPARD). Heading it is the company's director of research, George E. Spaulding, with Autolite since 1948.

Spaulding says that his Division will begin pilot production of subminiature hydraulic and electro-hydraulic devices for the missile and rocket field. Development work will be going on in electrical, electronics, and mechanical controls as well as in semiconductors and fuel cells.

• **How change came**—During the half century the company has been in business it has, except during wartimes, been devoted exclusively to the automotive industry. This was the way the late president, Royce G. Martin, wanted it, the way the company had prospered until the highly competitive fifties, and a way the company would have to change unless it wished to go full cycle back to its unobtrusive beginnings.

After Martin's death in 1954, patent attorney and industrial consultant James P. Falvey was named president. He brought New York financier Gurdon Wattles into the picture in late 1956, and by 1957 Wattles was chairman of the board.

This was the signal Falvey needed to chop down the archaic vertical managerial set-up and replace it with autonomous units headed by vice presidents, in several instances brought in from the outside.

Then, early last year, Robert H. Davies, industrialist and former vice president of Clarke Equipment Company, was elected president. Falvey was raised to chairman of the board, although he is now on leave to serve as Deputy Assistant Secretary of Defense for Supply and Logistics. Davies is eager to give Autolite a wider market and modern frame.

• **Hydraulic miniature**—G. W. Lewis, manager of mechanical engineering research, paints a fascinating picture of the miniaturization work Autolite is doing in the electro-hydraulic field. He expands his thesis by saying, "Hydraulics is today in its infancy in sophistication. There are areas of the field still untapped: for example, we are today in a 'direct flow' hydraulics which is analagous to DC electricity. Work that should be done is in 'pulse' hydraulics, analagous to AC."

He explains that by electronic means he can send out slugs of oil that pulse at a certain frequency and with certain phase relationships. "Thus, high energy can be transmitted over great distances with only small losses of energy. The analogy between AC and DC is obvious."

These techniques lead to great miniaturization, savings in power and money. Also, with pulse hydraulics it is possible to have a system with one hydraulic line instead of two. There would be rectifiers, transformers, subsystems and other devices peculiar to AC electricity.

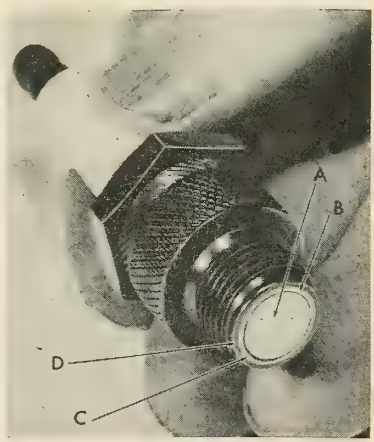
Lewis adds that, "Relationships between electricity and hydraulics would become so close as to enter an area that might be termed 'fluid electronics.' It's conceivable that electronic control of fluid flow would be done without any moving mechanical elements."

The practical results would be tremendous amplifications of tiny energies, high-speed control of machinery, and great precision in such control. Thus, pulse hydraulics would have a profound effect on the whole field of controls, computers, communications equip-

Autolite's Space Age Products

SUBMINIATURE electro-hydraulic valve cycles in a few thousandths of a second and can be actuated by an electromagnet.

AUTOLITE'S subminiature hydraulic pump is expected to find use in missile servo-control circuits.



SURFACE GAP plug has center electrode (A), semi-conductor gap (B), ground electrode (C) and shell (D).

← Circle No. 11 on Subscriber Service Card.

ment, and on any other field where pulse work or energy conversion is involved.

Here are details on the two Autolite advanced products, an electro-hydraulic valve, and a low-voltage surface-gap plug.

• **Electro-hydraulic valve**—This is a "pilot" valve in which a very small valve is actuated directly by an electromagnet; this in turn produces a hydraulic imbalance which opens the main valve member.

The action of the valve is very rapid in its response to "on" and "off" energization of the electromagnet. Open and close cycles of about 0.006 seconds are being obtained and even faster cycles are possible.

Taking advantage of their fast response, the valves may be used in digital or numerical control systems for precise positioning or precise modulation of process valves. Operating the devices by magnetic tapes or punched cards is being studied by Autolite.

While the valves are tiny by present standards, the flow capacity is 35 cubic inches/minute. At 1500 psi hydraulic pressure, this is more than one-eighth horsepower.

The valve is designed to be incorporated into the device that it controls or it may be arranged as an assembly in a valve block for various applications of electro-hydraulic controls.

The company is also developing subminiature pumps of size and capacity to service the miniature valves described. Incidentally, during World War II the company made hydraulic devices for autopilots and supercharger controls, and hydraulic pumps for armament. Autolite's hydraulic experience also stems from work it has done in making hydraulic units for power steering, power brakes and all the accouterments that hydraulics could power in a modern car.

• **Surface-gap spark plug**—This unique plug is unaffected by either liquid or solid deposits upon the firing surface. Thus it has considerable value as a liquid-rocket ignitor. This is borne out by the company's several years' experience with this plug in the ignition of fuels with low-atomization when compared with liquid-rocket fuels.

The spark plug consists of a center electrode and ground electrode separated by either a dialectric or semi-conductor material. The gap between the electrodes is on the order of 0.003 to 0.008 inches.

A high-power, high-frequency condenser of 5000 volts or less ionizes the surface of the gap material and makes a conduction path for the spark to travel from center electrode to ground electrode. This mechanism is known as "surface gap discharge."

Since the spark is not required to fire through air and since the gap is relatively small, this type of spark plug needs less voltage to initiate the spark and is, inherently, less sensitive to ambient atmospheric pressure variations than conventional air-gap spark plugs.

• **Insulator & wire**—In connection with its spark plug work, the company has done much research in the ceramics field. Out of this work they have devised an insulator body that, though weighing only 10 pounds per cubic foot, can withstand 3000°F. If higher temperatures and strength are desired, a 50-pound-per-cubic-foot composition can be made. It will withstand upwards of 5000°F and severe thermal shock.

Perhaps what is not widely known is that Autolite has for the past several decades been the country's largest supplier of high-temperature wire to the airframe manufacturers and lately to missile manufacturers. This work is a natural extension of the job Autolite has been doing in supplying wire to the automotive industry. The company is now developing high-temperature insulated wire able to operate in 1800°F and over environments.

A Missile Engineering Exclusive . . .

Design Details of Nord *5103*

by Jean-Marie Riche

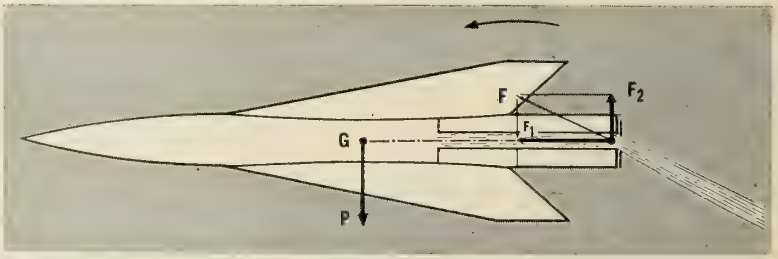
Paris—Specifications and performance data on France's air to air radio-controlled *5103* missile have just been released by the manufacturer, Nord-Aviation.

Currently in production, the missile is standard equipment or is being adapted to aircraft such as Dassault's Mystere IV A, Super Mystere SMB 2, Etendard IV M, Mirage III, Sud-Aviation's Vautour, Aquilon and the Fiat G. 91.

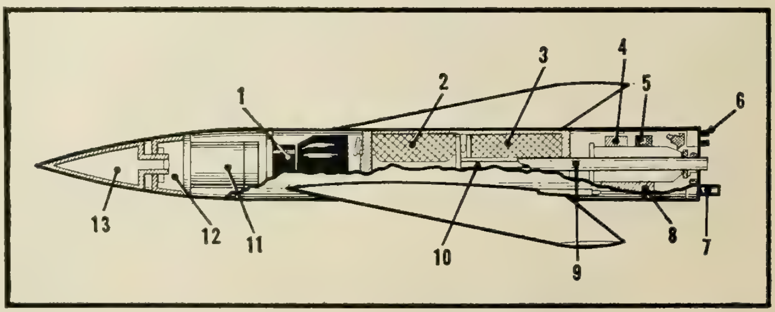
Designated the AA. *5103* Type M 2 RT missile, it is 8 ft. 6 in. long, 2 ft. 7.5 in. overall span with a body diameter of 9.84 in. and weighs 293±6.6 lbs.

The missile is supersonic, but its flight speed and range depend upon launching speed and altitude of the firing aircraft. Command guidance is by visual alignment. The missile is directed by the pilot using a control stick installed in the aircraft's cockpit.

• **Criteria**—In gaging the missile's performance, several factors must be considered. The three main ones are the speed increment at the end of the



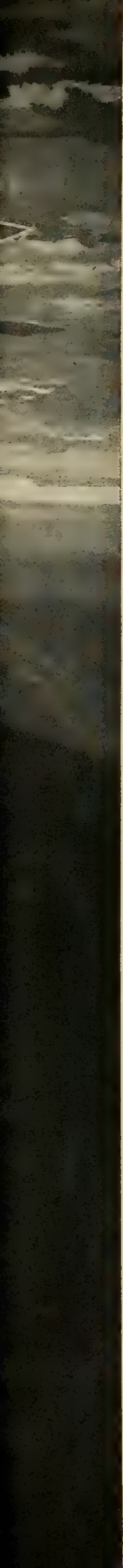
MISSILE IS CONTROLLED in flight through jet spoilers. The reaction force "F" may be broken down into a propulsion component "F1" and a sideways-acting component "F2" applied to the rear of the *5103*.



CROSS-SECTIONAL view of the *5103*. 1—warhead; 2—sustainer; 3—booster; 4—gyro; 5—relay; 6—quick release connector; 7—tracer; 8—command guidance link; 9—booster nozzle; 10—sustainer nozzle; 11—power pack; 12—proximity fuse; 13—nose.


The U.S. Air Force's
Atlas, produced by
Convair-Astronautics,
is the free world's
first ICBM and is now
operational with the U.S.A.F.
Strategic Air Command.
CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION

RECONNAISSANCE BY SATELLITE, one of many space jobs—World-wide weather data can be gathered by systems incorporating the Westinghouse Space Thermicon. Cloud cover and other meteorological data "seen" can be obtained at a high rate. Photo mapping is also possible from IR-stabilized vehicles.



1. SATELLITE STABILIZATION—Satellites must keep fixed positions in orbit if they are to perform the vital jobs foreseen for them. A key element designed for such systems is the Space Thermicon, an IR development at Westinghouse. This lightweight, static, electronically scanned "heat-seeing" device operates day or night, guiding the satellite by detecting and responding to Earth's infrared radiation.

2. DETECTING OBJECTS IN SPACE — Fire control systems in stabilized satellites can be designed around advanced Westinghouse infrared equipment. Here static, electronically scanned sensors with a wide field of view can detect and track objects, providing data at a high rate with high accuracy and top reliability.

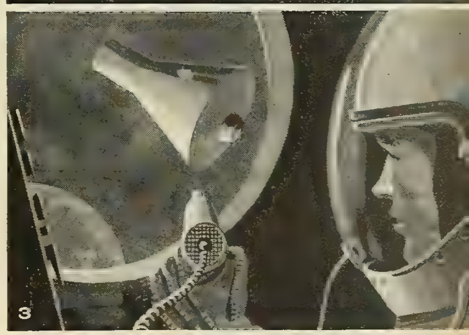
3. IR COMMUNICATIONS — Westinghouse developments will permit use of active infrared radiations to carry voices or other signals on a narrow microwave beam. Such a system would be almost impossible to detect or jam. It uses low power and requires little weight, and yet is useful for most communication requirements. Its "security" makes it particularly valuable in military applications.

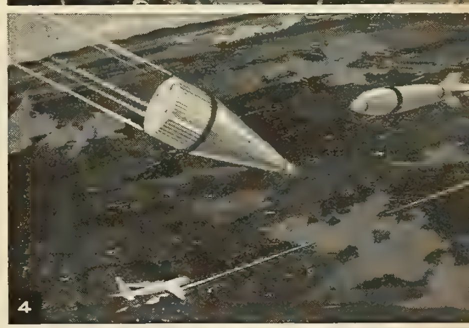
HERE ARE A FEW OF ITS IMPORTANT APPLICATIONS

4. AIRBORNE DEFENSE — Westinghouse-developed infrared devices, techniques, and systems, to detect and track enemy missiles or aircraft, offer vital advantages in both bomber defense and interceptor fire control systems. Such systems operate in daylight as well as darkness. Effective differentiation between targets and background is obtained.

5. TANK FIRE CONTROL — Infrared systems developed by Westinghouse offer special advantages such as 24-hour fire control capability. They are rugged, compact and cannot be detected by an enemy. Electronically scanned sensors eliminate problems of complex optical or mechanical linkage.

6. UNDERSEA DEFENSE — A broad program incorporating Westinghouse developments in scanning systems, sensors, and special circuitry make possible detection of submarines in a tactical environment.





Engineers at the Air Arm Division of Westinghouse Electric Corporation are developing a variety of advanced infrared systems for the Army, Navy and Air Force . . . another demonstration of *Westinghouse Capabilities for Defense.*

WESTINGHOUSE

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acceleration phase—the difference between the missile's speed and the aircraft's, absolute maximum range and maximum range ahead of the firing craft.

Specifically, if the *5103* is from a jet at an altitude of 33,000 ft. and traveling at Mach 1.2, the missile's speed increment will be 820 ft./sec. Its maximum absolute range will be 36,000 ft. and the maximum range ahead of the firing aircraft will be 14,400 ft. The speed of the *5103* along its own trajectory can vary with the firing conditions.

• **Hardware**—The main structural element is the case surrounding the motor. To this is attached the cruciform wings—slightly canted to induce spin, the warhead with tapered nose and the rear section.

A two-stage solid rocket motor makes up the powerplant. The booster, which operates for two seconds, is designed to provide thrust sufficient to leave the firing aircraft and attain enough speed to catch its target. The booster discharges through two diametrically opposed lateral nozzles.

The sustainer fires about one second after booster burnout and maintains thrust for about 20 seconds. Within the single axisymmetric nozzle of the sustainer, there are four jet spoilers which serve to deflect the gas efflux for the purpose of guiding the missile.

The spoilers are four knife edges which pivot about axis perpendicular to the plane of the nozzle orifice and which are designed to protrude into, or withdraw from, the exhaust jet. Each spoiler is actuated by an individual electromagnet. The distance between each pair of spoilers remains constant since diametrically opposite edges function in parallel.

• **Guidance method**—The missile spins about its roll axis. This means that, in order to change direction in a given plane, each successive diametrically opposed pair of spoilers must be energized the instant they lie in that plane.

In effect, successive pairs of coupled spoilers must act at each quarter spin of the missile. This command system is embodied in a powder-energized gyro, the outer gimbal of which pivots about an axis parallel to the missile's roll axis. A four-collector-ring, four-sector commutator integral with this gimbal ensures the correct distribution of the commands to the spoilers.

This gyro is started just prior to ignition of the booster and retains a fixed attitude throughout the flight of the missile.

The gyro, its command receiver, the command link receiver, and the relays are housed in the missile's rear section

together with the tubes connecting the nozzles with their respective firing chambers.

The tapered nose cone houses a group of instantaneous, self-activating A[illegible] batteries which supply 27 volts to power the spoiler electromagnets and 7 volts to operate filament heaters for the command-link receiver and proximity fuse. A high voltage static inverter supplies the receiver and the fuse.

The intermediate space between the motor and the nose is occupied by a pre-fragmentation charge weighing about 50 lbs. The explosive itself weighs 11 lbs. and its half hexogene-half tolite. Detonation of this warhead is accomplished either by the proximity fuse or by a self-destruction device after sustainer burnout. The detonator is fired by an electric initiator through an orifice normally masked by a protective flap.

• **Safety**—Three safety features prevent the warhead from being detonated while the missile is at rest or while too close to the firing aircraft. Self-destruction is automatic if the proximity fuse does not function at its appointed time.

The link between the aircraft and the missile is through a two-component system—the modulator and the pressurized transmitter. The transmitter is linked to the control stick through a co-ordinate transformer. This permits the missile to be guided independently of the firing plane's maneuvering. A free gyro aboard the plans is uncaged simultaneously with the missile gyro. The pilot then has a constant indication of the missile's reference system. The coordinate transformer translates into the missile's reference system the commands the pilot transmits in his own reference system.

The entire firing system must be energized two minutes prior to firing. In practice, this is actually done upon take-off. All switches and warning lights are laid out in the cockpit.

Substitution of a contact fuse and a 73 lb. warhead provides the *5103* with air to ground capability.

A three-point attachment is used to sling the missile from a special launcher which provides either ventral or underwing storage. Pyrotechnic stops lock the *5103* in place during flight but in an emergency the lower portion of the launcher, together with the missile, can be jettisoned.

advanced materials

Explosive Forming: No Panacea Seen

By John Judge

Explosive forming is no longer being heralded as the panacea for the metalworking industries. As with many other aspects of this missile/space business, limitations within high-energy rate forming process have proven more difficult than first anticipated.

E. W. Feddersen, chief of Manufacturing Research and Development at Convair, Fort Worth, told the Society of Automotive Engineers at their National Aeronautic Meeting in New York recently that the practical approach is being emphasized now in thinking about this versatile new form of energy.

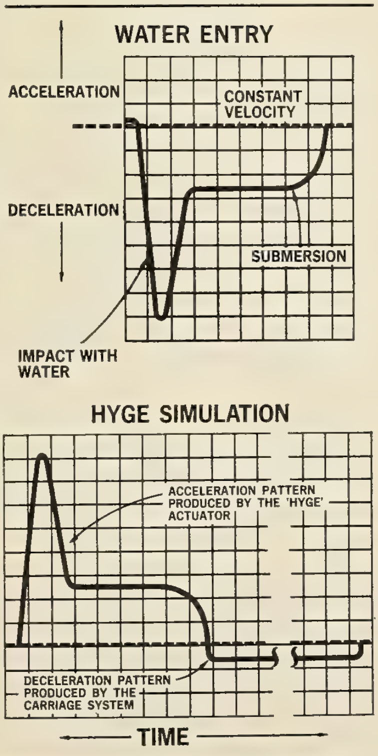
Feddersen said that other means of applying high-energy rates to the deformation of materials that do not employ explosive charges have been developed to a fairly reliable degree.

The Convair manufacturing expert split the field into three categories:

• Explosive forming—The shaping of materials by the exertion of sudden pressure from the explosion of a chemical charge.

• Hydro-Electric—The sudden triggering of electrical energy stored in capacitors, applied through a water or like medium, results in the deformation of materials.

• Pneumatic-Mechanical—Applying the high-energy rate by the sudden release of compressed gases. Current applications in each of the three systems range from laboratory to full-scale production.



CONVAIR'S HYGE simulation curve is an exact mirror image of the actual deceleration pattern experienced by a high speed body impacting in water. The G-loads are equal, but opposite in direction. **(See p. 39)**

Each has the same general advantages over conventional forming means—the ability to produce large, complex sections and the elimination of extremely large mechanical machinery.

But each in turn has advantages over the others when compared among themselves, especially in specific applications. Explosive forming does not lend itself to large-volume production and requires extreme safety measures. The hydro-electric method is accurate, repeatable and can be used within an inhabited factory because of the complete controlability. The pneumatic-mechanical method is semiconventional, using simple punches and complicated dies in some instances.

• **Participation**—Those mainly interested in explosive forming and its allied methods have been predominantly the airframe, missile and engine accessory manufacturers, Feddersen says. Relatively small quantities of parts, frequent configuration changes and a constant effort to stretch the defense dollar account for this.

Besides Convair, Ryan Aeronautical Co., Aerojet-General Corp., North American Aviation, Inc., Lockheed Aircraft Corp. and Boeing Airplane Co. have vigorous programs in this area. Talco Engineering Co. and E. I. DuPont de Nemours are among the metal fabricators interested.

According to Feddersen, Convair, like the others, followed the path of least resistance and involved itself initially in the expansion of preformed

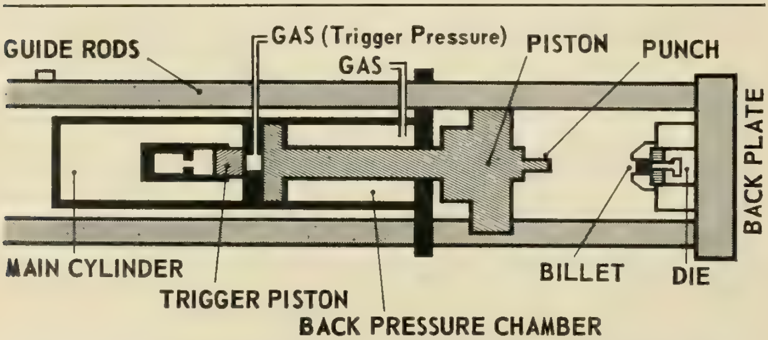
hollow bodies. All of these used explosive methods. Within the last year says Feddersen, Convair, along with Chrysler Corp. and Republic Aviation Corp., substituted electricity for dynamite and moved into the hydro-electric aspect of the process.

Early work involved high voltages from 14,000 to 22,000 volts and from 30 to 60 microfarads. Subsequent power increases were realized by reducing the voltage to 4000 and the capacity increased to 1200 microfarads. When the unit is fired, an initiating wire connecting the electrodes is transformed into a cylinder of metallic vapor. This vapor expands against the medium (water), the inertia of which causes a pressure build up from 15,000 to 20,000 atmospheres.

Feddersen said that the variable wave front was discovered and applied here. Various shapes of the initiating wire resulted in sharp-nosed, spherical and plainer wave fronts. Each of these fronts can be put to a specific job of forming.

• **Big savings**—The high-energy spark method was applied to the same ends as explosive forming—expanding and sizing hollow bodies. Feddersen said that when it comes to forgings, impact and straight extrusions, the third general method, pneumatic-mechanical, answers the need. The device is marketed under the trade name "Dynapak" and consists basically of a compressed gas driven piston. The machine can be used in forging, forming, extruding, compacting, shearing and blanking. Feddersen said the most common current uses are in forging and closed cavity extrusion molding.

In the fabrication of one particular part, a gas-tight corner, the Dynapak method resulted in a considerable cost saving. The Precision Forge Co., one of the two forging firms in the Los Angeles area who decided to try the method, produced the corner for Convair at a total cost involvement of $3,670.75. If conventional forging and machining had been used, the total cost would have been $9,984.04. The saving was effected through elimination of the machining steps.



PNEUMATIC-MECHANICAL Dynapak. The main cylinder is charged with compressed gas to the desired firing pressure. Trigger pressure is applied to the small space between the trigger piston and the main piston. This forces the trigger piston back and the main body of compressed gas acts upon the large piston, driving the punch toward the die at high velocity. The die housing is moving toward the punch at the same time, keeping all of the stresses created within the device. Hydraulic oil forces the piston back to its cocked position and pushes the gas back out of the main cylinder.

Feddersen concluded by pointing out that each method of high-energy rate applications has its own area of economical use. Right now they should be used only if the job cannot be done any other way, the finished product is better physically or when it is definitely the most economical approach.

Additional uses—The latest development in the Dynapak concept is simulation of the impact that occurs when a missile nose cone, or any other object, hits the ocean at supersonic speeds.

About six "water-entry" test facilities are in operation at Convair's Dynapak section—all involving the Hyge principle and the high-energy-rate forming machine.

The principle depends on the fact that g-forces are identical, regardless of their source. The abrupt deceleration of a body upon contact with the water creates huge g-forces within the body. Past simulation attempts centered around the use of resilient or semiresilient materials against which the test object was hurled. Even with acceptance of partial destruction of the facility with each test, Convair's engineers have been limited in the size and speed of test objects because the entire force created had to be absorbed by the testing facility.

• **Stresses reduced**—The Hyge water-entry simulator creates a shock load that exactly simulates the desired environment by pouring energy into the test object, in a controlled manner, rather than removing the energy. Since the test takes place during acceleration, deceleration can be stretched over a safe distance, thereby reducing the forces on the test equipment.

The heart of the Hyge system is the Dynapak device. A simple metering pin controls the air flow that pushes the piston. By changing the shape and length of the pin, a wide variety of shock patterns can be obtained on the same machine.

When testing for water-entry, the test object is located a short distance away from the piston. On firing, the piston builds up a tremendous velocity and transmits this to the specimen upon impact. The sudden energy input creates up to 5000-g acceleration in the carriage assembly. This shock is relatively shortlived, lasting only until the kinetic energy of the piston has been absorbed. Then the piston and the specimen move down a track together, accelerated by the compressed gas.

In effect, this technique reverses the water-entry conditions, the velocity achieved by the specimen at the end of the test approximating the speed of the object as it hits the water. A number of mechanical methods are used to slow the carriage down—the only requirement being that the deceleration g-forces remain low, avoiding any additional damage to the test specimen.

The tests are exactly reproducible since no damage occurs to the instruments. This has the effect of reducing cost of such tests and increasing reliability of components destined for such operating conditions.

Curved Honeycomb Panels Announced by Allied R&E

A new process at the Allied Research & Engineering Division of the Allied Record Mfg. Co. results in all-metal contoured honeycombs with any number or shape of curves, and in almost any size.

Material is presently available in high-purity nickel—with heat-resistant properties limited only by the melting point of nickel, 2651°F.

Skin and cell walls can be as thin as 0.0005 in., with skin and cell thicknesses having no bearing on each other. Cell size can be varied within the same structure or from one piece to another. It can be manufactured with load bearing inserts.

West Coast Gets Measuring Facility

High temps, vacuum, fluid flow, cryogenics and acceleration will be fields for Metrolonics, Inc.

COMPARATOR AND monochromatic light room at Metrolonics. For calibration purposes the latitude, longitude, elevation and gravity values have been exactly calculated for this particular room.

BURBANK, CALIF.—With the opening this month of Metrolonics, Inc., a new traceable calibration service now is available to the missile industry on the West Coast.

The company was established after 60th Air Force and Aerospace Industries Association surveys indicated the need for additional measuring facilities in the West.

Some 49 of 67 major contractors reported to AIA they were having difficulties in obtaining calibration services as quickly as needed. Certified accuracy of measuring devices after transportation from the East Coast was questioned.

In the Air Force survey, contractors also noted excessive times required and commented on frequent lack of traceability to the National Bureau of Standards.

Need for improved accuracies particularly was noted in these areas:

- Cryogenic temperatures.
- Acceleration.
- High temperature ranges associated with rocket engines.
- Vacuum.
- Fluid flow.

With a number of missile failures directly traceable to faulty calibration, the military now is beginning to enforce more rigidly the calibration standards required by MIL-Q-9858.

It is in anticipation of growing calibration demands from the missile industry that Metrolonics has been established, at an initial investment of almost $250,000.

"The services Metrolonics, Inc., will supply to industry have been generated by the new demands for Space Age precision," a company spokesman says. "Under recently revised regulations of the Department of Defense, all prime contractors and their subcontractors must demonstrate that their precision measuring instruments have been compared to and referenced to the primary standards in the National Bureau of Standards. Metrolonics' function is to provide the necessary link between the National Bureau of Standards and the multitude of manufacturers who must use precision measuring instruments."

A Metrolonics survey indicates there are some 2500 subcontractors who do not maintain their own calibration laboratories, although the military requires that all instruments used for precision measurements in such fields as optics, physical dimensions, electronics, micro-wave and infrared must be compared at specific times—usually annually—with "reference" standards which in turn are regularly compared with those at NBS.

• **The setup**—Preparations for the Metrolonics opening have been under way for more than a year. The metrology lab, devoted to physical measurements of length, time and mass now is complete.

Among the more than 50 types of measuring equipment it contains are the automated electronic interferometer for measuring gage blocks to 1/10-millionth of an inch by absolute measurement and the interference microscopes for measuring surfaces to less than one-tenth of a millionth of an inch; optical universal measuring equipment where components can be evaluated for size, roundness, and shape without removing the part from its position; and comparative optical instruments that can measure angularity to one-tenth of one second of an arc.

Under further expansion planned by Metrolonics, the electronics, microwave, optics and infrared laboratories will be established next, in that order.

Directing the technical and scientific activities of the company will be John A. Harrington, vice president-technical operations. Company president and treasurer is Donald S. Bibbero, with Donald G. Michealsen, Santa Barbara industrialist, as chairman of the board. Other officers include Alexander Glass, Jr., vice president and secretary; and Thomas G. Utley, vice president-administration.

Address of the new firm is 2201 N. Hollywood Way, Burbank, Calif.

LMSD Developing Inorganics

SANTA BARBARA, CALIF.—Lockheed Missiles and Space Division is developing inorganic coatings and semi-inorganic paints that combine the advantages or organic paints with better stability in space.

This was revealed at the recent American Rocket Society meeting here on structural design of space vehicles. The Lockheed work is part of a major program to study the stability of temperature control surfaces under combined vacuum, temperature and ultraviolet radiation and under rapid ascent heating.

Final result of the program is expected to be a set of stable surface finishes with predictable and desirable thermal radiation characteristics.

"For each structural material which may be used, such as aluminum and magnesium, a surface finish will be available in each of the four standard exterior surfaces plus any special sur-

faces which may have been developed for interior use," the Lockheed report said.

Information on all such surfaces will be compiled in a design handbook, the Lockheed researchers said. This will include not only characteristics but also manufacturing instructions, methods of application and control, and any special handling instructions such as the necessity for the use of a specific strippable paint. The book will be cross-indexed and will be in considerable detail.

"With the proposed design handbook," it was stated, "it will be possible for a designer, with little or no experimental verification, to select successful thermal control surface coatings for any given application."

Details of the program were given in a paper by Morris Steinberg, J. J. Fox and Bruno Augenstein. The researchers pointed out that a requirement of effective and flexible space vehicle thermal control is the development of four types of coatings that will not degrade appreciably over the projected useful life of the vehicle:

- A flat reflector—a surface having a low emissivity at all wave lengths.
- A flat absorber—a surface having a high emissivity at all wave lengths.
- A solar reflector—a surface having a low emissivity in the solar region (below about four microns wavelength) and a high emissivity in the infrared region.
- A solar absorber—a surface having a high emissivity in the solar region and a low emissivity in the infrared region.

Flat absorbers include some black paints such as the Dow 9 surface on magnesium-thorium alloy and black chromium electroplate, the Lockheed paper said. It reported that commercially available silicon-based black paints with carbon black or graphite pigmentation appear to be promising, possessing good resistance to ascent heating conditions. The development of soluble silicate, titanium ester, and silicone ester paint vehicles with suitable black pigments also is said to be a promising possibility.

• **Help from metals**—Some polished metals and even lightly oxidized metals act as solar absorbers, the paper noted. Aluminum with normal atmospheric oxidization is one such surface; metal-plated surfaces are another. It was noted that vacuum and electrodeposited surfaces on magnesium are generally of a poor quality with some manufacturing development work probably required.

A surface used in the *X-17* project, sulfamate of nickel is a promising plating material, the Lockheed researchers said, together with silver, "crack-free" rhodium, and crack-free platinum.

Able-Star Makes Technological First

by Jay Holmes

The Aerojet-General *Able-Star* scored a major technological first April 13 when it became America's first rocket to start and restart in space. So far, there has been no indication that the Soviets have done it.

Able-Star is an advanced model of the reliable *Able*, which, prior to the *Transit 1B* navigation satellite launching, had a record of 13 consecutive successes. Aerojet spokesmen said the two firings made the record 15 for 14 —a batting average of 1.070.

Despite the success of the new rocket, only a few are on order. The military will use *Able-Star* as an upper stage on the Army's Project *Courier* communication satellites, as well as the Navy's *Transit*. Both the military and the National Aeronautics and Space Administration are committed to the Lockheed-Bell *Agena B* for fulfilling much of their needs in restartable upper stages.

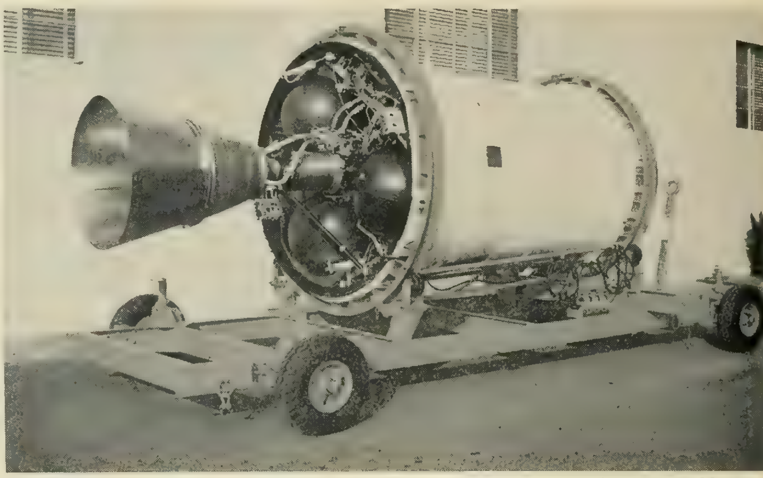
Agena B, a larger and somewhat more complex rocket, is in late stages of development. It is scheduled to be used in the Air Force's *Midas* and *Samos* early warning and reconnaissance satellites and for more than 60 NASA firings in the next 10 years. The first NASA *Agena B* is scheduled to be fired in the first quarter of calendar 1961. The first *Midas* firing is expected this year.

Able-Star generates about 8000 lbs. thrust for 300 seconds, a total impulse of 2.4 million pound-seconds. *Agena B* is expected to generate 15,000 lbs. thrust for about 240 seconds, a total impulse of about 3.6 million pound-seconds—about 50% greater than *Able-Star*.

• **Same combination**—Both rockets use the same hypergolic propellant combination—inhibited red fuming nitric acid and unsymmetrical dimethyl hydrazine (UDMH), which has a theoretical vacuum specific impulse of 276 seconds (1000 psia chamber pressure).

The major difference between the two is in the propellant feed system. *Able-Star* has a simple pressure feed, powered by three helium filled spheres. *Agena* uses turbopumps.

Thus the restart of *Able-Star* is accomplished simply by opening valves. In the *Agena B*, a solid-propellant charge is used to start the turbine pump.



FIRST ROCKET to gain start-restart capability in space is Aerojet-General's *Able-Star*, used on *Transit* navigation satellite.

A small kick also is necessary to force the propellant to the rear in a zero-gravity environment. In the *Able-Star*, this is provided from a container of cold nitrogen, which also supplies pitch, yaw and roll control while the vehicle is coasting. In *Agena B*, solid propellant will provide the propellant gravity and compressed air will be used for attitude control.

• **Virtue of simplicity**—Aerojet spokesmen said the simplicity of the *Able-Star* makes for greater reliability and lower cost. They said *Able-Star* development was begun by the Air Force last fall as a backup for *Agena B*. The simplicity resulted in faster development, they said.

Aerojet spokesmen said the cost of *Able-Star* is about half as much as *Agena B* per vehicle. Air Force spokesmen said the cost figures are classified.

Propulsion Side Effects May Endanger Man in Space

by Frank G. McGuire

Los Angeles—Side effects of certain propulsion systems may be dangerous to the crew of a space vehicle, the national meeting of the Institute of Environmental Sciences was told here.

Side effects, mainly strong magnetic fields, have been under study for some time; recently they have been getting more attention because of the approaching era of ion accelerators, fusion reactors, photon motors, and other "teratogenic devices" for space.

Dr. Harold S. Alexander, a psychologist at the Missile Division of North American Aviation, presented a paper on "Bio-Magnetics" to the meeting, citing experimental effects of magnetic fields on mice and calling the danger to the attention of propulsion system designers. The systems noted above involve the potential use of strong magnetic fields.

Dr. Alexander strongly emphasized, however, that "no extrapolation, based on the state of the art, from mice to men is presently possible."

Many of the propulsion devices now being developed for space feature strong magnetic fields which will undoubtedly affect the crews of vehicles —for better or for worse. One of the advantages promised by magnetic effects is suggested by the increased life

span of mice as well as their increased activity despite lower food consumption. All these phenomena would be beneficial to astronauts.

• **Dynamic testing**—In a paper entitled "Vertical Wind Tunnel and Six Degrees of Freedom—Dynamic Test Stand for Complete Missile Systems," T. C. Helvey of Radiation, Inc., proposes a method for saving hardware, time and expense of test firings.

Pointing out faults in current testing practice, Helvey notes that rigorous testing of components under single or even double environmental conditions causes a systematic error in complete testing because data cannot be extrapolated to multiple environment and dynamic stress conditions.

Noting that "The larger missile systems, according to the present and past experience, show structural integrity and operational reliability not higher than 15 to 20% . . ." Helvey suggests a vertical wind tunnel which would increase this figure significantly.

In the test stand suggested by Helvey, the missile would be placed in a heavily instrumented silo, in which it could rise a few feet. The missile would be placed in normal launching position, and in fact, each stage of a multistage vehicle could be tested individually.

The chamber would be wide enough to allow for a few degrees of drift from the desired vertical axis, much as in actual flight, until guidance corrections take effect. At the top of the silo, a jet engine—or a number of jet engines—would direct a high-temperature, high-speed airstream downward. This airstream would partially counteract the thrust of the missile's operating rocket engine.

This method would make it possible to test the same missile repeatedly in dynamic conditions, and to test modifications before flight tests prove them necessary, at the expense of a failure.

• **Hyper-environments**—"It is unfortunate that designers and environmental engineers are still influenced by the requirements of low-altitude piloted aircraft and are projecting from that base into the hyper environments. In fact, many of the old specifications are still being used with extrapolations."

Thus one of the basic problems in current environmental engineering is spelled out by M. H. Simpson of Frankford Arsenal. Analyzing the hyperenvironments and their effects on military hardware in the interior of a space vehicle, Simpson says there may be unexpectedly easy solutions to some problems.

Path resistance, attenuation, reflection, filtering, decay and other phenomena may possibly reduce the se-

verity of problems affecting hardware inside space vehicles. Extrapolating data from old specifications sometimes results in extreme rigor in some cases, and not enough rigor in others.

"The various parts (of a missile) must be unfailingly reliable, but only long enough to do the job required," Simpson points out, taking a slap at the school of thought that electronics equipment, for example, must operate for extended durations on the ground as well as in the air.

Bomarc-B Ramjet Tech Problems Appear Overcome

The ill-starred *Bomarc B* completed its test series at Cape Canaveral without a completely successful firing last week—but the first shot from Eglin AFB fulfilled expectations.

In the final shot at the Cape April 15, the solid-propellant booster and the ramjet sustainer ignited and performed well. But a malfunction in the experimental flight control changed the missile's attitude so much that the supersonic wind blew out the flame a few miles beyond the sight of observers.

The April 15 shot was the eighth at the Cape and the ninth altogether. In the first five, the booster fired but the ramjet did not, the Air Force said. Defense Secretary Thomas S. Gates has said the problem in the ramjet was pinpointed as one of valve functioning.

• **Problems solved**—Marquardt Corp., which manufactures the air-breathing kerosene-burning ramjet, said that although *Bomarc B* represents a substantial step forward in performance requirements, the technical problems encountered in the ramjet seemed to be solved. Boeing Airplane Co., prime contractor on *Bomarc*, said that although both powerplants operated satisfactorily, on the sixth test a random failure in the guidance system prevented complete success.

The seventh test was scrubbed when an accident caused a fire a short time before the countdown was to begin. The eighth was the successful shot at Eglin April 13, in which the missile traveled more than 170 miles.

Thiokol Chemical Corp., manufacturer of the solid-propellant booster, noted that the booster had a perfect record in flight tests.

AEC Approves NASA's Test Reactor Design

An Atomic Energy Commission committee last week approved the design of a test reactor built by the National Aeronautics and Space Administration at Sandusky, Ohio.

The AEC's Advisory Committee on Reactor Safeguards found that the 60 thermal megawatt device, called the Plum Brook Reactor, "should be capable of being operated without undue hazard to the health and safety of the public."

NASA plans to use the Plum Brook Reactor in testing the properties of materials irradiated at liquid hydrogen temperature (–423°F). The tests are necessary in the development of components for the Project *Rover* nuclear rocket.

The AEC committee did not comment on the operating procedures or the design of experiments using the Plum Brook reactor. In 1957, the committee concurred in the need of controlled holdup storage of radioactive gaseous and liquid products, because of the nearness to Sandusky. For the same reason, the committee said, "proposed experiments will have to be carefully reviewed and appropriate limitation may be necessary at this site."

Avco-GE Get Study Award On Plasma Propulsion

Avco Corp. and the General Electric Co. were chosen last week to make one-year competing studies of the feasibility of pulsed plasma propulsion.

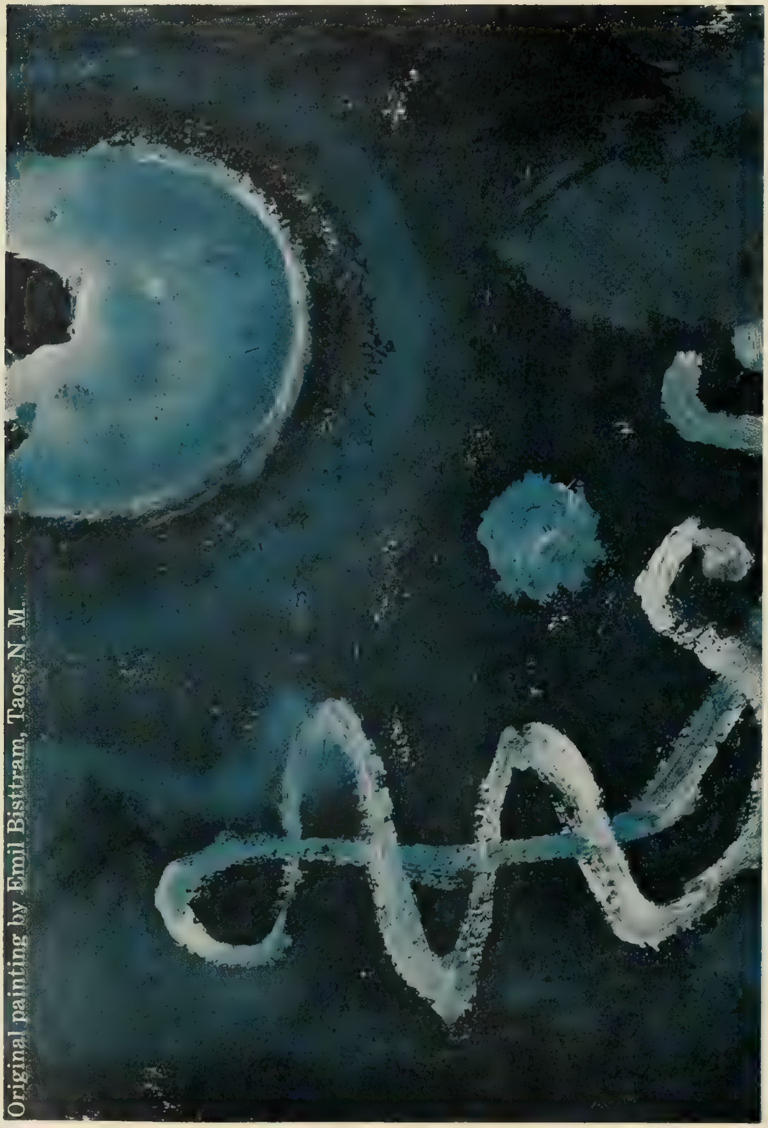
The National Aeronautics and Space Administration will award the two companies contracts totaling about $250,000 each to build and operate nonflying breadboard engines drawing 30 kilowatts of power and generating about ½ lb. thrust. Power in space would be supplied by a *SNAP-8* nuclear reactor, which is expected to be flyable in about five years.

NASA said it will decide at the end of the Avco and GE studies whether to go ahead and authorize development of a flyable plasma unit. Administrator T. Keith Glennan said their proposals offer "promising and different approaches to the problems this system presents."

The plasma jet's chief mission is expected to be the lifting of satellites and space vehicles from low earth orbits to the vicinity of the moon, in cases where the trip by ion propulsion would be too slow.

NASA said a major problem is the development of electrodes capable of operating reliably for two months or more.

Avco and GE were chosen over seven other competitors, Westinghouse, Rocketdyne, Republic, Aerojet-General, Plasmadyne, and Marquardt. One of the basic differences between their proposals is in the engine-cooling arrangement.



Shield Test Reactor Goes Critical at Oak Ridge

The Atomic Energy Commission has put in operation a high-powered nuclear reactor that will be suspended from 324-ft. towers to test the safety of operating nuclear-powered aircraft. The results will be applicable to nuclear rockets and ramjets.

The reactor at Oak Ridge National Laboratory, Oak Ridge, Tenn., is designed to operate at power levels up to 5000 thermal kilowatts for studying atmospheric scattering of radiation and for experiments in connection with the shielding of materials. It is designated Test Shielding Reactor 2.

Test Shielding Reactor 1, used in nuclear experiments that required suspension as high as 190 ft., was shut down in December, 1958, because it could not emit a uniform intensity of neutrons in all directions.

TSR-2 cost $1,090,000. It achieved criticality March 26.

Space Plastic, Lubricant Reported at ACS Meeting

A gamma radiation-resistant, flexible polyurethane material has been developed by B. F. Goodrich out of what once was a laboratory curiosity.

The elastomer, Estane (5740x1) can stand strong radiation doses before being rendered useless because its constituent molecules are not tied together by actual chemical means. This reduces the action of radiation which induces brittleness in elastomers by excessively binding polymeric chains together.

Dr. Charles S. Schollenburger, of Goodrich's Research Center, Brecksville, Ohio, told the American Chemical Society in Cleveland that the material's radiation-resistant qualities should find use in shielding personnel, on earth and in space, and in manufacture of gaskets, tubing, pads and binders for radiation applications in reactors, nuclear propulsion and other nuclear installations.

In another paper delivered before the Society, three Battelle Memorial Institute scientists reported the development of a new high-temperature lubricant.

Dr. H. H. Krause, Dr. S. L. Cosgrove and Dr. C. M. Allen said that the lubricant, metal-free phthalocyanine, will function effectively up to 1350°F. Lubrication over a wide temperature range in the absence of oxygen and water vapor is possible with the phthalocyanines. Lack of water vapor destroys the lubricating efficiency of graphite, one of the current high-temperature lubricants. The phthalocyanines are more familiarly known as dyes in coloring metals.

Industry Tells Navy How to Push ASW

If money and encouragement are given to industry working in the ASW field, then significant improvements in ASW techniques will probably follow, according to a report released this week by the National Security Industrial Association's ASW Committee. The Committee soberly warned that, "A major technological breakthrough should not be expected . . . in the ASW field."

NSIA is a nonprofit, nonlobbying organization of top industrial experts who combine their experience in technical committees to advise the Defense Department and other military departments on matters that affect the security of the United States.

Ninety-seven industrial organizations are represented on NSIA's ASW Committees, which have 318 members. They were honored for their work on April 13, when the Chief of Naval Operations awarded the Committee the Navy Certificate of Merit.

Last week the Committee's three-volume report of ASW data and recommendations was submitted to the Chief of Naval Operations. This is the Committee's first report on its findings except for a January verbal briefing given to Admiral Arleigh A. Burke.

• **Recommendations**—The Committee calls for the Navy to use in its Task Groups the most modern ASW equipment, even if it has not yet been formally accepted. In this way, evaluations could proceed parallel to paper work and much time saved.

The Committee wants those men in fleet and research ASW assignments to stay in their assignments for increased lengths of time so that professional-type ASW personnel can be developed.

Test ranges for evaluating torpedoes and other ASW missiles must key in with submarine developments. Hence the Committee is endorsing the Navy's endeavor to establish deeper and longer-range facilities.

The submarine is called the "best mobile sonar platform for ASW work." With this in mind, the Committee says, it wants a program for providing "adequate numbers of special-purpose, mobile, manned, sonar, underwater vehicles which would also contain data processing and communication equipment." The Committee also says that it hopes "the Navy will look favorably on the problem of industry acquiring and operating its own target submarines."

A flexible contract that allows a company to change its R&D emphasis, after military approval, if technical evidence calls for this change is recommended. Type contract asked for is Cost Plus Fixed Fee.

• **And further**—Here are some other recommendations:

The Navy should continue its policy of employing the use of service and

maintenance contracts with industry.

Navy and industry should strive to find a way to make proprietary information generally available.

More contracts should be written for feasibility studies in the ASW field and more money be made available for preliminary experimentation before specifications are written.

The Navy must increase its acceptance of the Fixed Ammunition concept to include major elements of weapon systems and perhaps complete weapon systems. For example, "there is no present technical reason why the Navy should continue to burden itself with shipboard overhaul and maintenance of its torpedoes. New design should feature a completely sealed torpedo with no possibility of test and adjustment."

There is a vital need for establishing an ASW Information Center. Some bibliographies have been made by the Committee, industry and the Library of Congress, but "a centralized information source with modern library facilities would be of immeasurable help."

• **Approvals**—The Committee unanimously endorsed the need for far greater activity in oceanography. It called out the following studies as ones where work is critically wanted: (1) opacity of sea water to various wavelengths of light, heat or other electromagnetic energy; (2) salinity versus depth and location; (3) temperature versus depth for various locations; (4) depth contours of the ocean; (5) ocean currents and current changes; (6) ocean tides and wave motion; (7) ocean bottom conditions; (8) gravity anomalies for the ocean; (9) magnetic charts and anomalies for the ocean; (10) biological studies as they relate to ASW; and (11) characteristics of submarine wakes in the ocean.

The Committee approved the creation of the ASW Readiness Executive Office of the Chief of Naval Operations. This office, it was said, has already given industry a feeling of confidence that worthwhile proposals will receive top rank attention.

Also endorsed was the establishment of the Office of Deputy Chief of Naval Operations (Development). This office has already initiated an Underseas Warfare Research & Development Planning Council, consisting of commanding officers and technical directors of eight Navy laboratories and directors of five nonprofit contractor laboratories.

Industry approval was given to the formalizing of the Navy ASW Committee, with the Secretary of the Navy as chairman. Members of NSIA's ASW Committee said they would cooperate freely and fully in any area in which they might be able to give help.

Radar Needed for Satellite Forecasts

SAN FRANCISCO—Radar stands as the only means by which precipitation detection can be achieved from a satellite for weather prediction, said two RCA meteorologists in a paper presented at the Eighth Weather Radar Conference here.

Lack of knowledge, they said, of actual occurrence and distribution of precipitation is a major deficiency of the observations being made by *Explorer VII* and the more recent *Tiros* weather satellite. (These vehicles employ IR horizon scanners for stability, radiation detectors and television cameras for surveillance.)

In their paper "Weather Radar Observations from Earth Satellites," J. E. Keigler and L. Krawitz of RCA's Astro-Electronic Products Div. describe a workable satellite-borne radar system having minimal design characteristics.

A nonscanning antenna beam, requiring no moving parts or sophisticated circuitry, could be employed in a system using today's state of the art, they said. Based on the application and extension of more conventional radar techniques, it could still use electronic scanning with suitable correlation techniques and precipitation-ground discrimination methods.

The power requirement would be well within the capability of contemporary solar power supplies, while the weight and size of the system, including the antenna, would be within the capacity of existing launching vehicles.

"Feasibility of this sounding radar already has been investigated thoroughly; it could be fabricated and placed in orbit now," Keigler-Krawitz said.

However, it also was noted that a radar satellite yielding full global coverage of precipitation at several levels would not be available in the immediate future.

• **Characteristics**—Characteristics of a minimal orbital radar system include a frequency of 10,000 mc, 80-kw peak power, 5-μsec pulse width, and an average power of 36 watts. It would have a duty cycle of 10^{-6} and a receiver noise figure of 10 db. Detectable radar cross-section would be 2 x 10^5 ft.^{2} at 800 miles. A system could be developed, they believe, weighing about 50 pounds and using a 4-ft paraboloidal antenna with a 1.75° beam width.

To avoid the high power required to oscillate an antenna transmitting over an appreciable angle at this rate (sweep frequency of 1/sec. for a beamwidth of 1° from an altitude of 300 nautical miles), the authors suggest that a continuously rotating antenna array might be employed.

For the receiving antenna they suggest one proposed by Dr. R. Wilmotte of RCA's Advanced Military Systems group: one that would revolve around a satellite at the end of a cable about 40 feet long, with the transmitting antenna fixed at the center of this circle.

The authors assume that the simplest and most accurately maintained

motion for the receiving antenna is one in which the plane of rotation remains substantially unchanged in space. This means that it changes position in relation to the earth such that objects on earth will have a motion relative to the antenna which will appear as a Doppler frequency in the echo signal reaching the antenna. Since the unique Doppler frequency is known for each point being surveyed, it is possible to resolve adjacent points.

To differentiate between ground return and precipitation, the authors explain that precipitation particle size, relative to a wavelength, causes its back-scattering cross-section to be a function of radar frequency. The heterogeneous ground return would be independent of frequency, hence simultaneous observation of a given elemental volume at two frequencies would indicate precipitation in volume proportional to the difference in returned signals at the two frequencies.

Since the precipitation has a vertical velocity relative to the ground, return from it possesses a Doppler frequency shift. A Doppler radar could double as the sensor unit for satellite stabilization to the local vertical, Keigler-Krawitz conclude.

Transit Success

Another Navigation Satellite Slated Soon

Successful orbiting April 13 of the ARPA-Navy *Transit 1B* satellite is expected to be followed within 60 days by another more "advanced" type which should eventually provide the world with a more truly accurate shipping and submarine navigation system.

First stage of the 265-lb. 36-in. spheroid was an Air Force-modified *Thor* IRBM; second stage was an Aerojet-General *Able-Star* rocket employing for the first time a new restart ignition

Thor-Able-Star Vital Statistics

First stage: modified Air Force *Thor* IRBM
- Weight—100,000 lbs. plus
- Thrust—150,000 lbs.
- Operating time—160 secs. after launch
- No guidance, but roll- and pitch-programmed control

Second stage: Aerojet General *Able-Star* engine
- Weight—1000 lbs. plus
- Thrust—7890 lbs.
- Operating time—300 secs. (258 sec. initial)
- Length—14'10"
- Dia.—4'7"
- Fuel and oxidizer—inhibited red fuming nitric acid, UDMH

Launch vehicle, both stages
- Weight—105,000 lbs. plus
- Length—79.3'

unit. Shutdown and restart capability was needed to kick the satellite into a circular orbit as it approached orbital altitude. This was the first try at restarting a rocket engine in space.

Restart attempt was successful but instead of achieving the desired 575-mile near-circular path, an elliptical orbit was attained: 479-mile apogee; 233-mile perigee. Its 96-minute period carries the satellite roughly from 51°N latitude to 51°S latitude.

Life span of *Transit* has been reduced from the anticipated 50 years to about 16 months.

• *Able-Star* **system**—For its first space launch, the *Able-Star* rocket engine was combined with a *Thor*. The Air Force was responsible for the launch vehicle and payload marriage, launch, flight and orbital control.

Initiated by ARPA, propulsion for the system was built by Aerojet-General; attitude and guidance subsystems were built by Space Technology Laboratories. STL also built and integrated all the other instrumentation.

Restart ignition was actuated by ground radio command from the AF Ballistic Missile Div.-STL mobile tracking station at Erding, Germany.

Developed by the Navy's Bureau of Weapons, *Transit 1B* is identical to its predecessor, which failed to reach orbit during a Sept. 17, 1959, attempt.

Eventually, four 50-lb. operational satellites will be employed for a near permanent world navigational system.

Transit 1B, powered by chemical batteries and recharged with cells, contains two ultrastable oscillators. Each transmits on two frequencies at 1-minute intervals: 54, 324, 162, and 216 mc.

Six ground tracking stations, with headquarters at Johns Hopkins University Applied Physics Laboratory in Maryland, are the principal data receiving centers.

• **Significance**—The immediate importance of such a system will be for military application, particularly for the *Polaris*-carrying nuclear submarines.

In using the system, analysis of Doppler shift will be employed to fix the position of a ship. To do this, precise knowledge of the time and satellite's position at that time is necessary. (This is simply the reverse of the method used to plot satellite orbits.)

Dr. Richard B. Kershner of Johns Hopkins APL, technical director for the program, estimated that future satellites designed for a 5-year working life will cost $1 million each to launch. A four-satellite operational system will cost roughly $3 million a year.

Target date for an operational system is tentatively set at 1962. Developmental costs over next two years will be $50 million, DOD officials say.

Japanese Steadily Prepare For Domestic Missile Making

by Kazuo Takita

TOKYO—Aircraft and electronics industries have started full-scale preparations in anticipation of a nod from the Japanese Defense Agency to start production of Japan's first home-grown missiles. Three models, a surface-to-air, an air-to-air and an antitank missile, are in the R&D stage under a $1.2 million appropriation this fiscal year (April 1, 1960, to March 31, 1961) and production on at least one will begin in 1961.

Under a new five-year plan for defense beginning FY 1961, all three services of the Japanese defense forces will be armed with guided missiles. In addition to its own models, however, some $3 million has been allocated for purchase of *Tartar* missiles for the Japanese Maritime Force and *Sidewinders* for the Air Force.

• **Industry leads**—The first move toward revamping facilities for missile production in Japan has been the trip by 14 top industry executives and engineers to the United States, Britain and Europe to study rocket production techniques. Headed by Yoshinaga Sake, president of the Mitsubishi Electric Co., the team is now on tour throughout Britain, West Germany, the Netherlands, France, Switzerland and Italy.

The Guided Missile Agency, a private organization with government support, has been a propelling force in orienting Japanese industry to missile production. In addition to organizing the current tour, it plans to sponsor construction of a supersonic wind tunnel and rocket testing facility.

The Japanese Defense Agency's Technical Research Institute has begun test production of a surface-to-air missile called the *TSAM-1*, expected to be very similar in configuration to the *Nike-Ajax*. It will have an ambidextrous propulsion system, capable of using both solid or liquid fuels, although Defense Agency plans call for a liquid-propelled version for *TSAM-1*, with a solid-fuel booster.

Speed of the missile will be Mach 2 with thrust capability of 2000 lbs., with booster thrust of 80,000 lbs.

• **Japan's missile schedule:**

• Domestic production will be started in 1962 of either *Nike-Hercules* or *Hawk* class (surface-to-air) missiles.

• Production will begin in 1965 of *Bomarc* class.

• Production of *Sidewinders* class will start in 1961. Eventual annual output will be 1500 to 2000.

• Experimental production of antitank missiles under study will be continued and full-dress production started in 1961. Annual production target will be set at between 300 and 400.

• Production of *Little John* class missile will begin in 1964.

The ratio of domestic production of these missiles is set at 20% for the initial years, but will eventually be raised to 70% for air-to-air and 90% for surface-to-surface missiles.

The antitank missile production will be wholly domestic throughout the program.

soviet affairs

By DR. ALBERT PARRY

Part of Russia's man-in-space research . . .
is being done in Czechoslovakia. This is evident from two items in recent issues of *Prague News Letter.* On Feb. 20 the Czech publication revealed the creation of a Commission on Cosmic Medicine in the Physiology Section of the J. E. Purkyne Medical Association in Prague, with 140 members. The first conference of these Czech space-medicine experts is announced for the second half of April, with "the technology of rockets and astronautics" as its main topic.

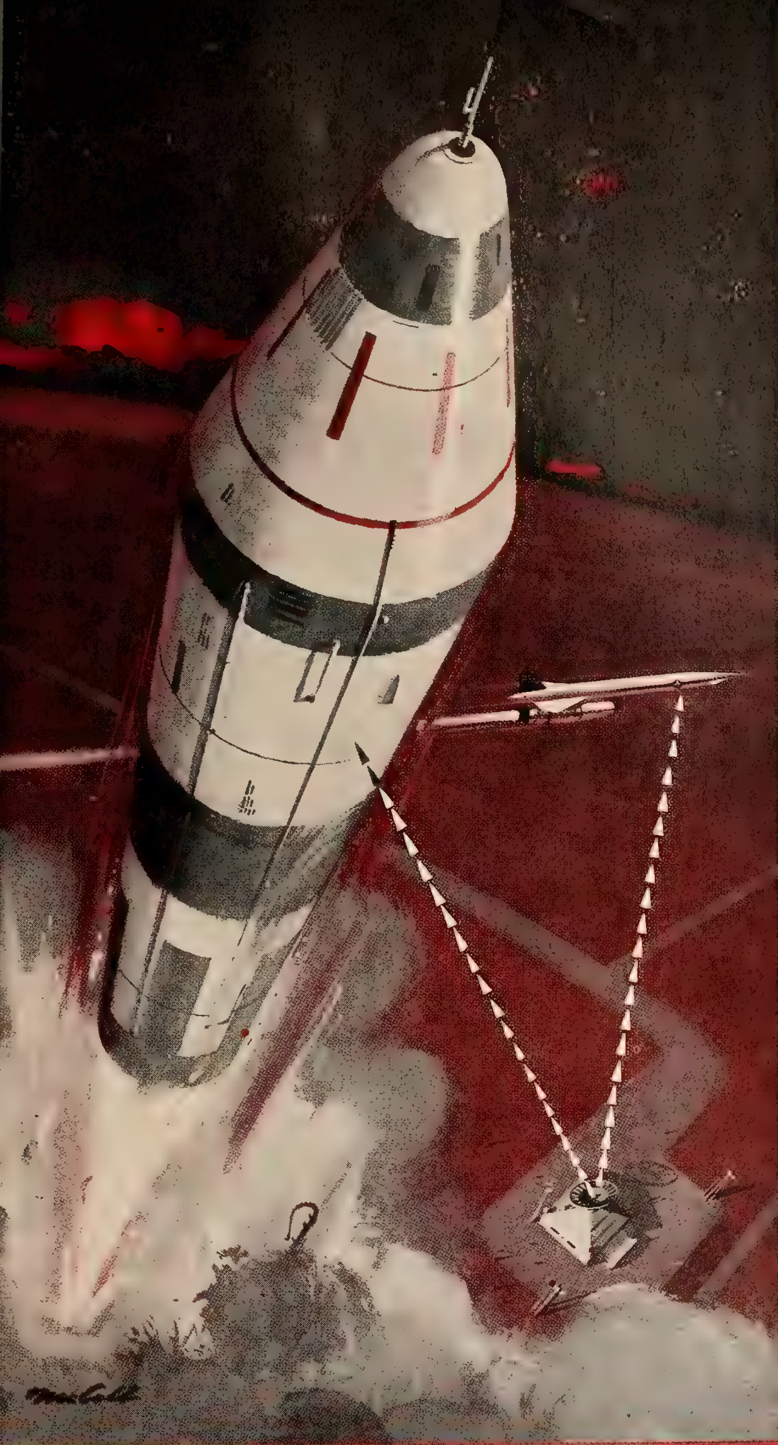
A film on space medicine . . .
has been made in Czechoslovakia and will soon be released for public showing. This we learn from the April 2 *Prague News Letter,* which prints an account entitled "Preparing for Cosmic Flight; Space Doctors Filmed at Work." The movie, one hour long and called "Before Man Steps Into Space," was produced in color by the Prague Popular Scientific Film Studio under the direction of Kurt Goldberger, whose previous films on medical subjects have won international prizes.

A giant centrifuge . . .
was used by the film's makers to reproduce the latest Czech researches on weightlessness. In it, prospective astronauts were whirled around in a cabin suspended on the end of a 30-foot rotating arm. The Czech article states: "The resulting centrifugal force acts like the accelerating and decelerating forces in a rocket. The tormented body of the human space guinea experiences only some of the arduous conditions awaiting the first space travelers. . . . We also see the strange behavior of liquids in a weightless state." This sequence was filmed by the Czechs in a large transport plane, converted into a movie studio, with lamps, cameras, and other objects carefully bolted down.

A large steel vacuum chamber . . .
was used for that part of the film where man's resistance to low air pressure and lack of oxygen was watched by the Czech doctors. Here altitudes up to 80,000 feet were simulated. At 24,000 feet a man was tested for his resistance to low atmospheric pressures. In one test, the subject (himself a doctor, who may or may not be an astronaut in training) was told to write consecutive numbers from 500 down. The log of his experiences tells us: "After five minutes his writing gets slower, his hand is heavy, and then he begins his losing struggle against suffocation." In the seventh minute he becomes unconscious. At low atmospheric pressure the subject's blood starts to boil at normal temperatures and gas blisters appear under the skin.

Solitary confinement . . .
to duplicate a two weeks' flight in a rocket was simulated for the film. These tests were conducted in a very narrow space within a steel cylinder resembling a rocket's cabin. The Czech description informs us: "The astronaut cannot even rise from his seat, suffers from limited sanitary conditions, and is subject to somewhat decreased atmospheric pressure." This solitary confinement in an air-tight, sound-proof cabin, completely isolated from the outside world, is supposed to last 336 hours. The man's nervous tension reaches its climax on the 12th day; he has hallucinations, and loses power to concentrate on his job. All this time, the Czech space doctors watch him intently on closed-circuit TV. Cardiographs, tensometers, encephalographs, and other instruments record every movement of his body, every action of his brain.

"Break-off complex" . . .
or a kind of mental depression, caused by a feeling of being cut from earth and fellow men, is an important target of Czech research and is dealt with quite dramatically in the film.



New from Crosley . . .

<u>miniaturized</u>

Command Receivers for missiles and drones

To meet the critical need for high-density packaging in missiles, Avco's Crosley Division has developed new miniaturized Command Destruct Receivers that weigh only three pounds.

Their task: To receive and act upon instruction from the ground to destroy a missile that has gone out of control.

In the Command Destruct configuration for range safety and similar applications, the miniaturized Command Receiver has four channels incorporating a decoder, to provide a secure link between the ground station and missile.

For high-performance drones and decoys, there are similar miniaturized Command Receivers that employ a 12-channel network. These receivers will actuate control surfaces, direct engine operation, and open a recovery parachute—all by radio-conveyed ground instruction.

Today Avco/Crosley Command Receivers are standard equipment on most of the nation's missiles. And by meeting the most severe environmental and operational requirements they have proved themselves for the future.

For more information, write to Vice-President, Marketing-Defense Products, Dept. M-CR, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio

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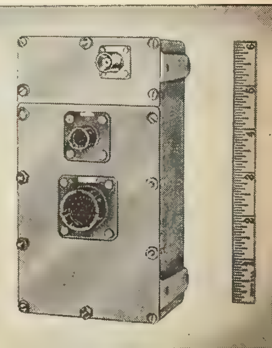
New Crosley Command Receiver is about the size of a kitchen match box.



names in the news

Dr. Milo P. Hnilicka: With the firm since 1952, promoted to the new post of scientific assistant to the vice president and director of research for National Research Corp. He will continue to serve as a consultant in various aspects of space technology, particularly the simulation of the environment of outer space.


HNILICKA

Rear Adm. Sir Matthew Slattery and **Peter G. Masefield** have resigned from Bristol's board and from their respective appointments as chairman and managing director. **Sir Reginald Verdon Smith,** chairman and joint managing director of the Bristol Aeroplane Co., appointed chairman of Bristol Aircraft and **Dr. A. E. Russell,** former chief engineer' technical director. **J. F. Harper,** former assistant managing director of Bristol appointed director and general manager. **D. J. Farrar,** formerly chief designer, guided weapons, promoted to chief engineer, guided weapons.

E. Paul Jackson: Appointed marketing director, Eastern region, for Rocket Power-Talco division of The Gabriel Co. Prior to joining the firm was manager of special projects for Fairchild Engine and Airplane Co.


JACKSON

John A. Moreno: Appointed executive assistant in charge of engineering administration at the Pomona Division of The Marquardt Corp.

Frederick Stevens, Thomas H. Quayle and **William A. Jones:** Promoted to newly created positions as vice presidents of Northrop Corp.'s Nortronics Division. Stevens is in charge of the electronic systems and equipment department at Hawthorne; Quayle directs the systems support department at Anaheim, and Jones heads the precision products department in Norwood, Mass.

Maxwell White: Named manager of the newly formed advanced systems research dept. of the Military Systems-Stavid Div. of Lockheed Electronics Co. Earlier served as a project manager and project engineer at the Martin Co.-Baltimore in connection with the *Minuteman, Matador* and *Mace* programs.


WHITE

Dr. James King, Jr.: Joins the technical staff of Electro-Optical Systems, Inc., as a senior scientist in the energy research division. Was previously a senior research engineer at Atomics International in the solid state physics group, where he researched measurement of thermal properties of solid materials at high temperatures.

L. J. Braun: Appointed director of corporate contracts for American Bosch Arma Corp. Was previously president and director of sales for Tele-Dynamics, Inc., acquired by American Bosch Arma Corp. in February, 1960; now a division of the corporation.


BRAUN

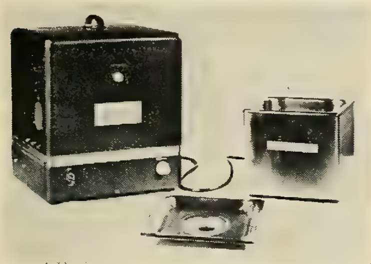
William R. Carlson: Formerly with Raytheon's Semiconductor Division, joins the Semiconductor Division of General Instrument Corp. as planning and controls manager.

Edward J. Rhoad: Appointed a senior scientist at Hughes Aircraft Co.'s ground systems group. Was formerly project manager of Frescanar, an advanced radar development for the U.S. Army.

Ultrasonic Cleaner

McKenna Laboratories has developed an ultrasonic cleaner featuring several simultaneous ultrasonic frequencies.

In addition to the "Poly-Sonic" feature, the V-100 provides thorough



cleaning because it produces uniform concentration of ultrasonic power throughout the cleaning chamber. Completely uniform cleaning results are obtained throughout the volume of the container even in a parts basket. Another feature of the "Poly-Sonic" units is the more effective cleaning through the use of heated solutions.

The V-100 runs at 400 KC with overtones of other frequencies ranging down to 20 KC. 400 KC removes dirt particles down to 1 micron in size and penetrates into small crevices and recesses. The lower frequencies provide cleaning action required for larger dirt particles and provide cleaning on areas that are not accessible to high frequency because of shadowing.

Circle No. 225 on Subscriber Service Card.

Standard Missile 'Clock'

A 400 cps-frequency standard—featuring extremely high stability under rugged environmental conditions and varying input voltages—has been designed and developed for use in missiles by the Electronics Division of Bulova Watch Company, Inc.

The unit's most important application is said to be as a "master clock" type of frequency standard to assure generation of precise and stable frequencies for missile guidance and fire control systems.

Bulova designates the frequency standard as its Model MB400.

Input requirements are 28 volts D.C. (25-29vdc), 1 Vrms ripple. Maximum power required for the unit's oven and oscillator circuitry is 11 watts. The output of 400 cps (plus-or-minus 10 ppm) is a square wave 2 volts peak-to-peak minimum into a 1 kilohm load.

The 400 cps (± 10 ppm) frequency is maintained throughout temperature ranges of —20 +71 degrees C at vibration levels of 5 to 2000 cps at 15g and up to 100g shock in all directions. An additional tolerance of ±10 ppm is necessary when the MB400 is operated at temperatures ranging from —55 to +85°C. The unit can be stored at —55 to +120°C.

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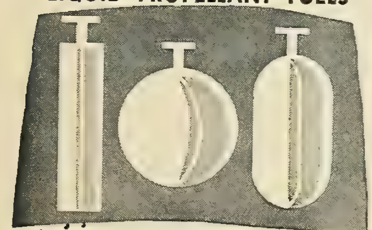
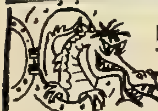
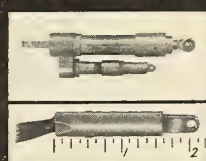
Novel Air Flow Meter

The first air-flow measuring device with direct "deadbeat" readings has been developed by the Highland Engineering Co.

Designed for the Air Force MB-1,







presently being built by Highland, this unique flow meter has a revolving drum-type dial 25 inches in circumference permitting direct read-out of all flows from 20 to 200 CFM at any pressure from 2 to 12.5 PSIG. The circular dial's long calibration range of 25 inches, plus dampening by paddles turning in oil in the drum reservoir, provide direct deadbeat readings at any point throughout the circumference of the dial, a degree of accuracy previously unobtainable in airflow measuring equipment.

The dial is actuated by a turbine wheel attached to a spring wire stretched within a vertical duct. As airflow velocity rotates the turbine wheel, the torque created is opposed by the spring of the wire, thus registering the rate of flow on the circular calibrated dial.

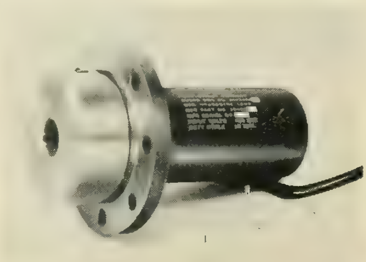
Pressure drop through the device is less than 1/10th pound and it has passed 8g acceleration tests. The design is suitable for air or liquids, can be constructed from nearly any metal—also glass, fiberglass or plastic—to handle practically any conditions of temperature or corrosion.

For extremely wide ranges of flow velocity, it is necessary to use more than one unit, a range of 5 to 1 being accurate to 1%.

Circle No. 227 on Subscriber Service Card.

Small Impeller Pump

Hydrodyne Corp., engineers and manufacturers of gas and liquid controls, have announced production of a small centrifugal impeller pump for heavy duty work in areas requiring subminiature equipment. Designed



originally for Naval Ordnance, this unit delivers up to 8 gpm at 150 psi. It's designed to handle salt water and certain other corrosive fluids. Normal temperature limits are −60° to 350°F. Duty limit is 10 minutes. It's sealed at the shaft with the Skinner Rotary Face Seal, a product manufactured by Hydrodyne's Skinner Seal Division, which withstands pressures to 600 psi. Principal materials used in this pump include aluminum housing and bronze impeller. Power source is direct current electrical pump.

Circle No. 228 on Subscriber Service Card.

new literature

HEATING ELEMENT. A complete 16-page catalog describing Electrofilm's new "wire mesh" heating element is now available from Electrofilm, Inc., of North Hollywood, California. In addition to detailing the exceptional "reliability" features of this new wire mesh type heating element, the catalog also gives complete technical data as to its versatility, physical properties and thermal characteristics, as well as a visual description of the varied components now being used in the aircraft, missile and space age fields.

Circle No. 200 on Subscriber Service Card.

HIGH TEMPERATURE ALLOY—A booklet, "W-545 Vacuum Melted High Temperature Alloy," is available from the Westinghouse Electric Corp. This 12-page technical data booklet is complete with photomicrographs showing structures of the material and many tables and graphs illustrating the material's properties. In addition to general information on applications, other sections of technical data booklet 52-263 deal with metallurgical characteristics, physical properties, mechanical properties, creep and creep-rupture properties, availability, and material processing of W-545 alloy. W-545 alloy is an austenitic iron-base alloy containing nickel, chromium and relatively small portions of molybdenum, titanium, boron, silicon and manganese. This alloy is precipitation hardened and was developed primarily to meet the need for improved gas turbine discs, one of the most critical components of jet engines. It has exceptionally high creep strength combined with good ductility and excellent oxidation in the temperature range of 1000 to 1350°F—the range in which gas turbine discs operate.

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BROCHURE—The Pennsalt Chemicals Corp. has published a brochure titled, "The Cleaning Of Processing And Handling Equipment For Liquified Gas Producers And Users." The brochure treats each separate liquified gas problem individually, and elaborates on some of the detailed procedures used in cleaning.

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CHART. Ronan & Kunzl Inc. has available an 8½ in. by 11 in. wall chart showing the gaseous equivalents of one through 5000 gallons of liquid oxygen, nitrogen and argon. The chart shows the cubic feet of gas available when the liquid is converted into gas, and the approximate number of high-pressure cylinders is also shown.

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contracts

NAVY

Radar Relay, Inc., Santa Monica, Calif., for electronic control display units for *Polaris* checkout system. (performed under $200,000 in contracts to **Nortronics Div., Northrop Corp.**).

$20,000,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., for navigation systems and field engineering for the *Polaris* submarine fleet. ($8,817,022 for design and manufacture of navigational systems; $10,868,269 for field engineering.)

$2,000,000—**Chance Vought, Range Systems Div.**, for instrumentation of the S. S. Skidmore Victory for use on the Pacific Missile Range.

NASA

$114,000—**National Research Corp.**, Cambridge, Mass., for development of special satellite instrumentation and related testing equipment.

$48,000—**Fischer Research Laboratory, Inc.**, Palo Alto, for indicating millivolt potentiometers for general use in tunnel tests.

$27,230—**Task Corp.**, Anaheim, Calif., for internal strain gage balance, for use with low-life type vehicles in the 8 x 7 supersonic wind tunnel.

$26,820—**Precision Instrument Co.**, San Carlos, Calif., for one 14-channel recorder-reproducer for tests in 12 ft. wind tunnel.

AIR FORCE

$12,000,000—**The Hallicrafters Co.**, Chicago, for production of electronic countermeasure equipment designed to disrupt hostile radar and missile guidance systems.

$2,600,000—**Westinghouse Electric Corp.**, for tactical scatter communications equipment.

$1,272,00—**Motorola, Inc., Semiconductor Products Div.**, Phoenix, for reliability improvement of semiconductors for the *Minuteman*. Sub-contract from **Autonetics Div., North American Aviation, Inc.**

$1,091,483—**Research, Inc.**, Eden Prairie, Minn., for building temperature sensing and recording devices used in research on missiles.

$600,000—**Boeing Airplane Co.**, Seattle, for *IM99A* mobile inspection equipment.

$384,910—**Boeing Airplane Co., Pilotless Aircraft Div.**, Seattle, for copy suitable for photographic reproduction and photolithographic negatives applicable to the *IM99A* missile. (5 contracts)

$225,000—**Space Electronics Corp.**, Glendale, Calif., for further research and development on a terminal guidance system for the *Titan*. Sub-contract from **Avco Corp., Research and Advanced Development Div.**

$134,125—**Barnes Engineering Co.**, Stamford, Conn., for infrared tracking systems and ancillary equipment.

$47,740—**Ryan Aeronautical Co.**, San Diego, for radar components.

$42,765—**General Electric Co., Defense Electronics Div.**, for design study of a satellite ionospheric sounder.

$40,800—**Consolidated Electrodynamics Corp.**, Albuquerque, for recorder/reproducers.

$33,730—**Consolidated Electrodynamics Corp.**, Albuquerque, for recorder to be used in support of Project *WS-133A*.

ARMY

$10,500,000—**Thiokol Chemical Corp.**, Bristol, Pa., for production of rocket motors and plant maintenance at the Longhorn Ordnance Works, Marshall, Tex.

$4,800,000—**Chrysler Corp.**, for the *Jupiter* ($2,796,382 for modification of ground equipment; $2,018,983 for missile components).

$3,457,070—**Radioplane Div., Northrop Corp.**, for 400 target missiles.

$2,184,000—**Temco Aircraft Corp.**, for manufacture of components for the *Hawk* missile.

$227,650—**Raytheon Co.**, Waltham, Mass., for concurrent repair parts for *Hawk* missile.

$167,140—**IMSCO**, El Paso, Tex., for *Nike-Hercules* Battalion headquarters facility Walker AFB.

$162,509—**Robert L. Scott**, San Antonio, for construction of guided missile field maintenance shop.

MISCELLANEOUS

$2,600,000—**Raytheon Co.**, Santa Barbara, for continued work on a fire control system for the *Shillelagh*. Subcontract from **Aeronutronics Div., Ford Motor Co.**

$1,000,000—**Lear, Inc.**, for manufacture of universal component test stands for rocket engines. Subcontract from **Rocketdyne Div., North American Aviation.**

reviews

SHORT TIME HUMAN TOLERANCE TO SINUSOIDAL VIBRATIONS, G. H. Ziegenruecker and E. B. Magid, WADC. Order PB 161083 from OTS, U.S. Dept of Commerce Washington 25, D.C. $.50.

The experiment tested the voluntary endurance limit to which healthy men could tolerate sinusoidal virbrations. These vibrations appear to be a vital environmental element in rocket propelled, manned space vehicles during launching and re-entry operations. The vibratory flight environment was simulated by an instrument monitored, mechanical shake table.

During tests, the frequency of vibrations ranged from 1 to 15 cps. Observations showed that tolerance limits were the result of one or more of seven specific sensations.

Test subjects reported dull pains, short breath and malaise increasing in intensity with time and vibratory rate.

SURFACE EFFECTS ON SPACECRAFT MATERIALS, Edited by Francis J. Clauss. Transactions of the Symposium Co-sponsored by the Missiles and Space Division of Lockheed Aircraft Corp. and the Air Research and Development Command, U.S. Air Force, Palo Alto, California, May 12 and 13, 1959. John Wiley & Sons, New York, 404 pp., $11.50.

The temperature control problem in space is initially treated with methods of calculating the required radiation characteristics of surfaces, experience to date with space probes and satellites in this area and methods of measuring the radiation characteristics.

The effects of environmental conditions in space on the surface and structrual properties of materials, ultraviolet radiation, the myriad effects of high vacuum on mechanical properties, interplanetary dust distribution and its erosive qualities are among the subjects handled in the rest of the papers in the collection.

—when and where—

APRIL

The Combustion Institute, Western States Section, Spring Meeting, sponsored by Lockheed Aircraft Corp., Palo Alto, Calif., April 25-26.

ASME Maintenance and Plant Engineering Conference, Chase-Park Plaza Hotel, St. Louis, April 25-26.

American Welding Society, 41st Annual Meeting and Welding Exposition, Los Angeles, April 25-29.

2nd Southwestern Metal Exposition and Congress, State Fair Park, Automobile Bldg., Dallas, April 25-29.

National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton-Gibson Hotel, Cincinnati, April 27-28.

British Interplanetary Society, High Altitude Chambers and Pressure Suits, Church House, London, April 28.

MAY

Society of Aerospace Materials and Process Engineers (SAMPE) Eastern Division, Spring Meeting, Massachusetts Institute of Technology, Cambridge, May 3.

National Association of Relay Manufacturers, Eighth Annual Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, May 3-5.

Materials Handling Exhibition and Convention, Mechanical Handling, sponsored by Associated Iliffe Press, Dorset House, Stamford St., London, May 3-13.

Properties and Application of Materials in Aerospace Vehicle Design, sponsored by The Martin Co.-Denver, Park Lane Hotel, Denver, May 4-6.

National Machine Tool Builders Association, 58th Spring Meeting, The Roosevelt Hotel, New York City, May 5-6.

Radiation Research Society, Annual Meeting, San Francisco, May 8-12.

Aerospace Medical Association, 31st Annual Scientific Meeting, Miami Beach, May 9-11.

1960 Symposium of the Institute of Radio Engineers' Professional Group, on Microwave Theory and Techniques, Hotel del Coronado, San Diego, May 9-11.

Instrument Society of America, Instrument-Automation Conference and Exhibit for San Francisco, Brooks Hall, San Francisco, May 9-13.

Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel and State Fair Park, Dallas, May 9-13.

1960 Electronics Components Conference, sponsored by Institute of Radio Engineers Professional Group on Component Parts, American Institute of Electrical Engineers, Electronic Industries Association, Hotel Washington, Washington, D.C., May 10-12.

New York University, Conference on "The Critical Million—How to Talk to the Nation's Scientists and Engineers . . . Industry's Most Vital Audience," New York City, May 17.

Second *Polaris* Underwater Launch Test Is Successful

SAN CLEMENTE ISLAND, CALIF.—The Navy passed another milestone in its fleet ballistic missile crash program here when the Lockheed *Polaris* successfully achieved ignition after an underwater launch. All phases of the test worked perfectly and the missile roared to approximately 1800 feet with its cut-grain propellant charge.

Four days later another *Polaris* test vehicle ripped from the Observation Island surface test ship off Cape Canaveral. The launching was successful, but the missile fell short of its scheduled 900-mile flight because of premature trailing off of the second-stage motor. There was no immediate indication as to the seriousness of the problem.

But success of the underwater test indicates the Navy will succeed in its drive to have two FBM submarines —George Washington and Patrick Henry—on station by the end of this year. The George Washington has already fired "a number of sets of complete salvoes" from her tubes. The missiles used were the *Dolphin* operational configuration.

The April 14 test of the ignition system was the 67th launch from the Navy's San Clemente sea test range, and the first in which ignition was achieved—from either surface or submerged tubes. The first attempt at ignition was made on March 27, resulting in failure "when a pair of relays closed in the wrong sequence." This circuit was modified to prevent a recurrence on the second attempt.

After the initial "Fire" signal at approximately 2:19 p.m., the sequence of events was quite rapid. The missile left its submerged launcher, broke the ocean surface within two seconds, achieved ignition instantaneously, and roared off to the northeast without losing momentum.

• **Faster than expected**—The rapidity with which the *Polaris* ignited after clearing the surface startled many observers, who expected a second or two delay while internal events had time to occur. The tail of the missile appeared to be within 18 inches of the surface when flames sprouted from the nozzles.

A simplified guidance system quickly pitched the vehicle over into a ballistic trajectory, and the propellant charge carried it to less than 2000 feet before burning out and allowing the missile to fall. The remainder of the rocket casing was filled with an inert propellant to bring the weight of the vehicle up to fifteen tons. Powered flight lasted five seconds.

A three-link telemetry system was used for flight test data.

ADVERTISERS' INDEX

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Only Industry Can Insure Reliability

Recently we published a story describing successes in the battle to improve parts reliability in electronics (M/R, March 28, 1960). The two companies reported on are representative members of an industrial community trying vigorously to solve a never-ending problem—man's inability to reach perfection.

In the field of missiles and space vehicles, equipment must meet requirements for operation throughout astronomical lengths of time and distance, in an unknown environment, with exquisite accuracy. It can be allowed only infinitesimal failure probabilities.

In this realm, success is not only a noble objective—it is an absolute necessity.

And yet in this boldest of struggles to conquer space, we find our progress retarded by incompetency, delay, unhealthy competition and even plain greed.

Time after time incompetent vendors are awarded subcontracts solely on the basis of shaved prices and fast delivery promises.

The huge and costly engineering systems built to conquer space rarely fail because of failure in the design concept. They fail because of malfunction or nonfunction of some minor part which costs an infinitesimal part of the whole—a valve or tiny electrical connection.

And because of these tiny failures million-dollar missiles collapse and burn on the launching pads.

The Procurement Act of 1948 requires formal advertising for all general procurement (10 U.S. Code, Section 2304) with award to the lowest responsible bidder.

Under the act is a list of exceptions for negotiated contracts; government interpretation of these has generally worked well for the major contracts to the big primes. The Services, for instance, use what is known as the "two-step advertising system." A no-price bid is requested to establish competency, then price bids are requested from a selected few.

Procurement by the primes and large subcontractors is a different story. Specifications—which may run into thousands for MIL-type parts as passed from government to prime contractor—may lack as much as 12 months of being current. They may even be subtly incomplete because the original makers (around whose products they were written) were trying, understandably, to protect their proprietary rights.

The government has passed the ball to the primes and main subs to buy the thousands of component parts on the specifications.

If the company is conscientious, it makes certain that its engineers update MIL-spec requirements and that its buyers purchase only from vendors who can prove reliability and competency. It demands—by instituted policy—that buyers consider workmanship and performance ahead of price and delivery date.

If the company is other than conscientious, or if its purchasing agents are incompetent or ignorant—or if they are allowed to operate under a policy of expediency—then the buying will frequently be at the expense of reliability.

We have a great belief in U.S. industry, in its competency and its integrity—in its great pride of product. Most of it is conscientious, and most of it has set up rules and procedures to buy the best and the most reliable product.

But there are those who have put the fast buck ahead of integrity, the slick deal ahead of reliability. They are the companies which must be weeded out of the missile/space industry. And they can be weeded out—by government regulation, by industry boycott and by exposure to public opinion.

Clarke Newlon

DOW | *Now in magnesium and aluminum*

FOUR MAGNESIUM DEVELOPMENTS ANSWER DESIGNERS' PROBLEMS

New Dow developments in magnesium provide solutions to critical problems for aircraft, missile and electronics designers. Among them are: a special bend sheet; new close sheet tolerances; precision extrusions; elevated temperature alloys.

Heated dies are not necessary with Special Bend sheet.

NEW SPECIAL BEND SHEET bends easily on standard bending equipment at room temperature. This AZ31B-O Special Bend sheet can be cold-bent without cracking through an angle of 90 degrees around a mandrel radius equal to the bend factor times the nominal sheet thickness . . . bend factor for .040″ to .100″ sheet thickness is 2.0! And tensile yield strength meets the requirements of Federal Specification QQ-M-44.

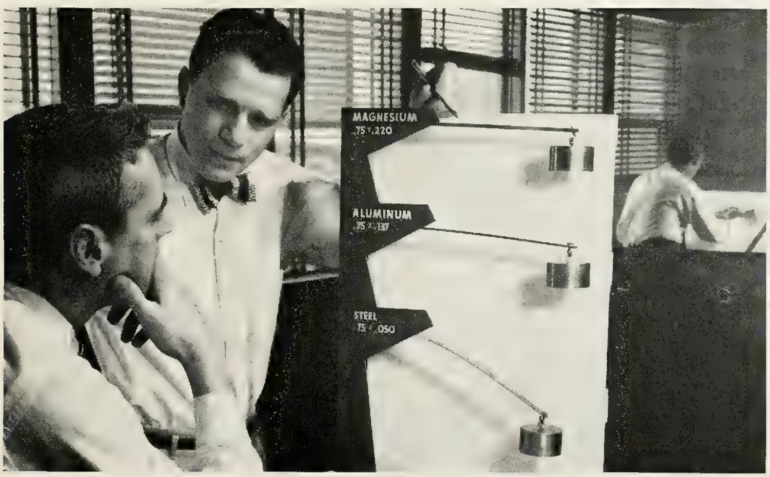
NEW CLOSE SHEET TOLERANCES can now be obtained on standard gauges when required. For example, on .090″ gauge, 48-inch-wide sheet, tolerances can now be held as close as plus or minus .002″. Standard tolerances run plus or minus .004″. These closer tolerances help to cut down on weight penalty, so important in missile and aircraft design.

PRECISION MAGNESIUM EXTRUSIONS from Dow give you exact-tolerance parts without costly multiple machining operations. Sharp V's, deep notches, thin slots, accurate serrations . . . all can be economically produced in Dow's Madison, Illinois, extrusion plant.

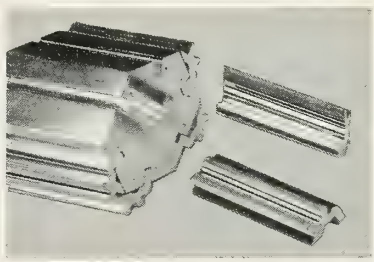
LARGE EXTRUSIONS. A huge 13,200-ton press easily handles large sections, stepped extrusions, combined extrusion forgings and single unit extrusions to replace fabrications. This giant can handle sections of up to a 30-inch circumscribed circle!

ELEVATED TEMPERATURE ALLOYS are available from Dow for extruded and rolled products. These alloys have excellent static and creep properties, some up to or above 700°F. Because of magnesium's high specific heat, it's an excellent heat sink for instruments and components!

Compared pound for pound with other metals, magnesium permits the use of heavier-gauge, more rigid sections for extra structural strength . . . and substantial weight savings!



Magnesium gives greater rigidity for equal weight than other metals.



Dow precision-extrudes magnesium in almost any cross-sectional shape.

For more information on these products, and on Dow's fabrication facilities for magnesium and aluminum, contact the nearest Dow sales office, or write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1002CL4-25.

See "The Dow Hour of Great Mysteries" on NBC-TV

DOW **THE DOW METAL PRODUCTS COMPANY**

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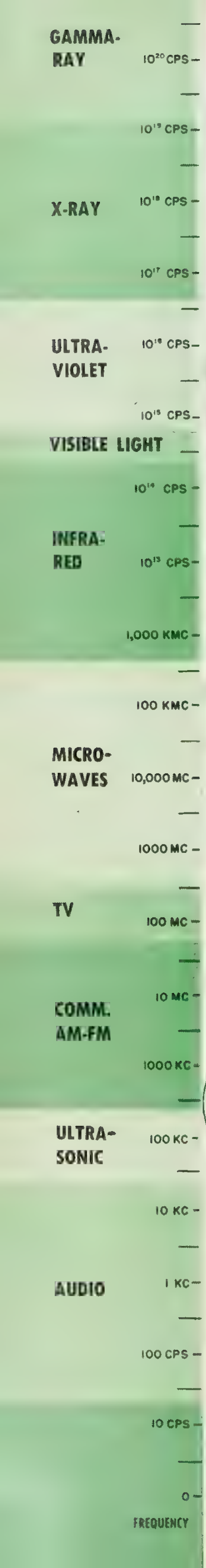

"...working in the 90-220 kmc frequency ranges?"

- *Crystal, Bolometer, and Thermistor Mounts.*
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- *Slotted Sections.*
- *Precision Variable Attenuators.*
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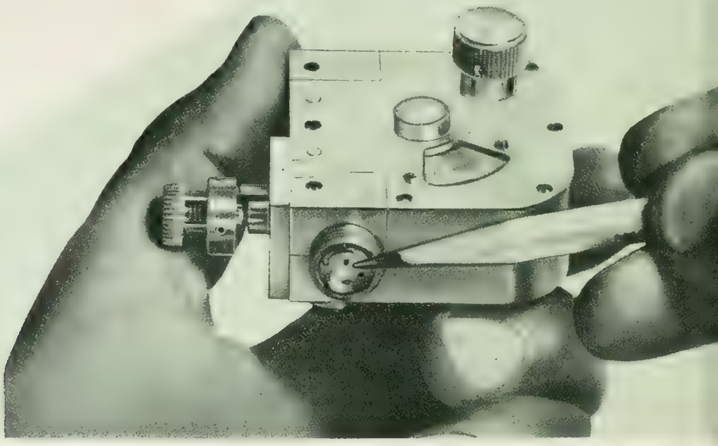
- *E/H Tuners.*

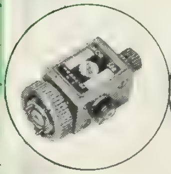
Other components shown below.

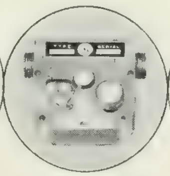
Slotted section, shown here, actual size.



FXR's Newly Developed and Proven 2-3 MM Components are Marvels *of Precision and Reliability*

These miniature F-Band and G-Band components are not scaled down versions of their lower frequency counterparts. Rather, they are instruments of individuality and precision — products of advanced microwave engineering and new manufacturing techniques.


DETECTOR MOUNT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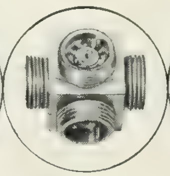
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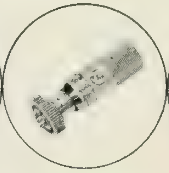
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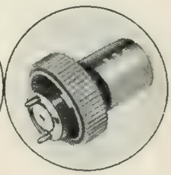
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